SEP 21 1949

1949, No. 3 SEPTEMBER 15

COPEIA

Established in 1913

PUBLISHED BY
THE AMERICAN SOCIETY OF ICHTHYOLOGISTS
AND HERPETOLOGISTS

Copeia *1949, No. 3* *September 15*

CONTENTS

OBSERVATIONS ON LAYING, DEVELOPMENT, AND HATCHING OF THE EGGS OF *Batrachoseps wrighti*. By *Robert C. Stebbins* 161

NOTES ON *Rana sylvatica* IN THE LABRADOR PENINSULA. By *Henry Hildebrand*..... 168

NOTES ON THE LIFE HISTORY OF THE SALAMANDER *Aneides aeneus*. By *Robert E. Gordon* and *Richard L. Smith* 173

OBSERVATIONS ON THE HABITS OF THE HORNED LIZARD *Phrynosoma m'callii*. By *Kenneth S. Norris* 176

DARK COLORATION IN THE REPTILES OF THE TULAROSA MALPAIS, NEW MEXICO. By *Thomas H. Lewis* 181

SEXUAL DIFFERENCES AND NORMAL PROTOGYNOUS HERMAPHRODITISM IN THE ATLANTIC SEA BASS, *Centropristes striatus*. By *Nathan Lavenda* 185

THE FAMILY NAME OF THE CHARACID FISHES. By *George S. Myers*..... 195

CHANGES IN THE CRANIAL NERVES OF THE PADDLEFISH, *Polyodon spathula*, ACCOMPANYING DEVELOPMENT OF THE ROSTRUM. By *R. Weldon Larimore*..... 204

VARIATIONS IN THE BLOOD CELL VOLUME OF INDIVIDUAL FISH. By *R. T. Young*..... 213

ICHTHYOLOGICAL NOTES—The Systematic Position of the Apodal Fish Genus *Bathymyrus*, by *James Böhlke:* 218.—Hurdling by the Needlefish, by *Paul L. Swanson:* 219.—New Records for the Pirate Perch, *Aphredoderus sayanus* (Gilliams) in Central-western Ohio, by *Clarence F. Clark:* 219.—The Capture of an Atlantic Salmon (*Salmo salar salar*) in the Connecticut River, by *Daniel Merriman* and *Yves Jean:* 220.—The Angel Shark, *Squatina dumeril*, in Southern New England Waters, by *Daniel Merriman* and *Yngve H. Olsen:* 221.—A Case of Poisoning by a Stinging Catfish in the Philippines, by *Albert W. C. T. Herre:* 222.

HERPETOLOGICAL NOTES—Longevity of Snakes in Captivity in the United States, by *C. B. Perkins:* 223.—On the Dorsal Sail of *Dimetrodon*, by *Simon Rodbard:* 224.—Observations of the Feeding Habits of the Juvenile Cantil, by *E. Ross Allen:* 225.— Occurrence of the Turtle *Graptemys barbouri* in Georgia, by *John W. Crenshaw, Jr.*, and *George B. Rabb:* 226.—The Status of Baird's Chorus-frog, by *Wilfred T.Neill:* 227.—Two Cases of Snake Bite in New Guinea, by *Wilfred T. Neill:* 228.—The Young of the Lizard *Sceloporus poinsettii*, by *L. W. Ramsay* and *E. T. Donlon:* 229.—Notes on the Young of the Blue Racer, *Coluber constrictor flaviventris*, by *Ernest A. Liner:* 230.—The Toad *Bufo valliceps* in Arkansas, by *Hobart M. Smith* and *Dave A. Langebartel:* 230.—Early Bullfrog Transformation, by *W. D. Klimstra:* 231.—The Hibernation of Three Snakes and a Salamander, by *Roy A. Grizzell, Jr.:* 231.—A White Spadefoot Toad from the New Mexico White Sands, by *Clyde P. Stroud:* 232.—Ophiophagy by a Juvenile Copperhead, by *A. J. Barton:* 232.—*Medaestia* Wussow, 1916, A Synonym of *Testudo* Linnaeus, 1758, by *Robert Mertens:* 232.—The Smooth Green Snake in Texas, by *William B. Davis:* 233.—Further Northern Records of the Wood-frog, by *Clyde L. Patch:* 233.—Notes on the Desert Whiptail Lizard in Utah, by *Jess Lombard:* 234.—Nest and Eggs of the Southern Dusky Salamander, *Desmognathus fuscus auriculatus*, by *Wilfred T. Neill* and *Francis L. Rose:* 234.

EDITORIAL NOTES AND NEWS—Western Division Meeting: 235.—Fish News at University of Michigan: 235.—News Notes: 236.

Published quarterly by the American Society of Ichthyologists and Herpetologists, at the Museum of Zoology, University of Michigan, Ann Arbor, Michigan, under the Act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized February 11, 1924. Printed by Ann Arbor Press, Ann Arbor, Michigan.

Observations on Laying, Development, and Hatching of the Eggs of *Batrachoseps wrighti*

By Robert C. Stebbins

On April 1, 1948, an adult female *Batrachoseps (=Plethopsis) wrighti*, heavily laden with eggs, was obtained at the type locality, 8.7 miles southeast of Sandy, Clackamas County, Oregon. Since the eggs of this salamander were unknown, she was brought into the laboratory in the hope that oviposition could be observed. She was placed in a gallon glass container with a metal screw lid. A single paper towel, wetted with distilled water, was put into the bottom of the jar. The container with the salamander was kept in a dark room where the temperature was maintained continuously at approximately 12° C. Thermal data on field animals suggested that this temperature might be commonly experienced under natural conditions.

After nearly one month in captivity, the salamander still retained her eggs. Dispairing of obtaining them without stimulation, I employed the pituitary implantation technique described by Noble and Richards (1930) and thereby oviposition was initiated. Implantation was done as follows. On May 25, 1948, at 3:40 P.M., I implanted a single whole pituitary gland freshly removed from an adult male *Hyla regilla*. The salamander was anesthetized in chlorotone (1 part saturated solution to 3 parts water), whereupon a small incision was made in the skin of the gular area. The *Hyla* pituitary was removed with forceps and was transferred directly to the site of the incision. A dissecting needle was used to force the gland into place beneath the the skin. By the time the salamander recovered from the chlorotone, several hours later, coagulation of blood and lymph at the site of the operation prevented displacement of the implant. About 42 hours later, a second *Hyla* pituitary was implanted. On June 1, 1948, at 9:00 A.M. the first egg was laid. Laying was completed June 2 at around 9:00 P.M., approximately 36 hours after the beginning of oviposition. Eleven eggs were deposited. Their chronology was as follows: June 1—3 eggs laid at approximately 2½ hour intervals, around 9:00 A.M., 11:30 A.M., and 2:00 P.M.; June 2—8:40 A.M., 7 eggs present with the 8th emerging; 1:30 P.M., 9th egg emerging; 7:15 P.M., 10 eggs; 9:00 P.M., 11 eggs.

The brief description of the eggs (Stebbins and Lowe, 1949), may now be supplemented [see Fig. 1, (1)]. The most striking characteristic of the eggs is their size. After some hours on the wet paper towel of the container, the jelly layers had swelled enormously, measuring, to their outer surfaces, 9 to 10 mm. The female salamander, only about 5 mm. in greatest width, seemed incredibly small to have deposited such large eggs (see Fig. 2, A). When laid, the jelly layers were thin and the vitellus was elastic, permitting its passage, with some temporary distortion, through the cloacal aperture. The vitellus, or egg proper, was unpigmented, between Cream Color and Pale Ochraceous-Buff.[1] It rotated with the animal pole uppermost when the egg

[1] Colors from Ridgway, 1912.

was rolled about. The fluid-filled vitelline chamber, in which the ovum moved, was but slightly larger than the egg itself, the boundary of the chamber lying about .1 to .15 mm. beyond the surface of the vitellus. The vitellus measured 4 mm. in diameter. Two gelatinous capsules were present. The inner one, sometimes differing in width from one side of the egg to the other, measured from 1 to 2 mm. in thickness. It was composed of a stiff jelly and under transmitted light was seen to be minutely concentrically laminated. An inner zone appeared to be slightly differentiated but it did not form a distinct layer, hence was viewed as part of the inner capsule. The outer capsule was composed of rather firm, elastic jelly that was diagonally furrowed on its outer surface. These furrows were probably the result of the configuration of the walls of the oviduct associated with spiral movement of the egg in passage. The jelly layers were colorless and entirely translucent with about the same refractive index as water. News print could be seen undistorted when viewed through the capsule of an immersed egg.

Although several eggs in the clutch were deposited separately, all gave evidence of having been related to one another in a chain arrangement. A number of the eggs upon deposition remained connected, like a string of beads. Others possessed remnants of the connecting strand, although they had become separated from the chain. The connecting jelly strand was about 1 mm. in diameter and about 20 mm. long between each pair of eggs. This strand was continuous with the outer jelly layer of the egg and was similarly translucent. The outer gelatinous surfaces seemed not particularly sticky, as the eggs could be separated readily and moved about. They did not adhere to the substratum.

All the eggs were fertile despite the fact that no male had been with the female while she was in captivity. Fertilization must have been by sperm stored in her spermatheca. Thus it is evident that such sperm can be carried for at least a month. The length of time that viable sperm can be stored by this species and other plethodontid salamanders poses an interesting problem, related to the phenomenon of delayed fertilization in snakes and turtles (Rahn, 1940, and others).

The procedure in caring for the eggs was as follows. Once a week the eggs and salamander were transferred to a clean jar that had been washed in hot water, cooled, rinsed with distilled water, and provided with a fresh paper towel. The eggs were handled with a teaspoon. No attempt was made to achieve complete asepsis. At one time, for a period of a week, a solution of methylene blue was daily pipetted onto the eggs but since the gelatinous capsules began to assume a bluish cast and the eggs had appeared in good condition before the treatment was begun, it was stopped. The adult animal was left with her eggs to see if she would exhibt brooding behavior. In addition it was thought that her dermal secretions might have a bactericidal and fungicidal effect. She was not fed while she was with the eggs for fear of contamination of the brood chamber through introduction of pathogens with food.

Development

Hatching occurred on October 13, 133 days (approximately 4½ months) after completion of oviposition. During the developmental period, the eggs were kept at, or near, 12° C. To what extent the time required for development in the laboratory corresponds with that necessary for normal development in the field is unknown. It is doubtful that a constant temperature would prevail even at a nesting site situated well underground. Over a period of several months in late spring and summer there would be a significant steady rise in temperature unless the eggs were laid at depths of several feet. Were the eggs deposited near the surface, they would be subjected to diurnal thermal rhythms of low amplitude with a general trend toward higher temperatures as summer came on. I suspect that the temperature at which our laboratory brood was kept may have been somewhat lower than that at which eggs commonly develop in the field, particularly in the later stages.

During the developmental period, stages in embryonic growth were studied. Such observations were necessarily limited because of my desire to obtain hatchlings. Several embryos, however, were preserved at different stages of growth and from them and the living eggs, gross aspects of development can be reported (see Fig. 1).

An egg was examined on June 4, 2 days after it was laid. Segmentation of meroblastic type was in progress. The entire upper surface of the egg appeared granular due to the presence of numerous minute cells. The cells became larger peripherally, finally giving way to a marginal zone with cleavage furrows that extended in various directions into the remaining unsegmented portion of the egg. Most of the vegetal half of the egg had not yet undergone division. The type of cleavage noted here was like that recorded for *Aneides lugubris* by Miller (1944).

On June 7 an egg was examined that seemed to be in the blastula stage. The entire surface of the egg was cellular. The upper quarter of the sphere was translucent, indicating the presence of a cavity. No blastopore could be found, hence gastrulation seemed not to have begun.

On June 11 gastrulation was in progress. Each of several eggs examined possessed a crescentic furrow on its surface. Opposite the crescent nearly half the egg was translucent, probably from the presence of the gastrocoele.

By July 13, the embryos possessed head and tail folds and both anterior and posterior limb buds were present. Laterally situated paired elongate swellings in the cephalic region presaged the appearance of the gills. The eggs were now ciliated. One examined rotated clockwise, requiring 3 mm. and 45 seconds for a complete revolution at 24° C.

On August 6 the embryos were again studied. Circulation had been established, apparently for some time. Figure 1, (4) to (7), shows the larvae at this time. Gills were well developed, melanophores had appeared, the optic cups were heavily pigmented, the nasolabial grooves, mouth, and cloacal aperture were apparent. The heart was noted as projecting to the right. The limb buds had become elongate but the digits had not yet made their appearance.

On August 17 the embryos had become darkly pigmented except for the yolk mass.

On September 7 the yolk covered most of the area between the limbs. The embryos now lay close to the surface of the capsules, which had become progressively thinner. The embryos occasionally moved about within the vitelline chamber.

On September 24 the gill on one side consisted of two primary divisions that diverged from a common base. These divisions gave off 3 to 5 finger-like subsidiary lobes. The gill in life was unpigmented, translucent, and succulent [see Fig. 1, (9 and 10)]. Blood passed outward into the gill beneath its ventral surface and returned dorsally. In each lobe of the gill there seemed to be basically a single vascular loop. Erythrocytes commonly passed along these loops in single file. The loops hence were of capillary size. Figure 1, (9), shows roughly the number of blood vessels on the dorsal side of a gill. A comparable set was present on the ventral side. Movement of blood could be seen clearly. Between heart beats negative pressure existed in the branchial vessels as evidenced by the slight backward movement of the blood. The gills throbbed with each pulsation of the heart. At 27.4° C., with the egg immersed in normal saline for cold bloods, the pulse rate was 86 beats per minute.

The gill of *Batrachoseps wrighti* differs considerably from that of certain other plethodontids whose gill structure has been studied. *Aneides lugubris*, as figured by Miller (1944), has trilobed gills that are extensively vascularized. The gills of *Ensatina eschscholtzii* resemble those of *Aneides*. *Batrachoseps wrighti* approaches *B. attenuatus* in gill structure but the gills of the latter species, as described by Emmel (1924), show still further restrictions in respiratory surface and vascularity. As indicated by the skeletal feature of paired premaxillae, the more plethodon-like habitus, and the high percentage of nucleated red cells, the gills of *B. wrighti* further attest to the more generalized nature of this salamander as compared to *B. attenuatus*.

While under observation the gills of the larva atrophied. The embryo was removed from the egg and was placed on a damp paper towel in a covered dish. On September 25, a day after removal from the membranes, the gills of this individual were represented by small opaque gray stumps. Although disinclined to move voluntarily when stimulated with a needle, the young salamander flipped its hindquarters toward the source of irritation and crawled away in a co-ordinated manner. No gular action could be seen. Righting behavior was present although the animal was slow to respond.

Hatching

Hatching commenced on October 13, 133 days after oviposition. When first observed at 2:00 P.M., the female salamander was found among her eggs with her gular area applied to one of them (see Fig. 2, A). A recently hatched larva lay at her side. Only once previously had she been seen to assume this position. It was thought that in some way she might have been attracted by the hatching of the eggs. Previously she had shown rather complete indifference to them. Whether she would have remained near the eggs had she been given more room, is unknown. Adults of *Batrachoseps*

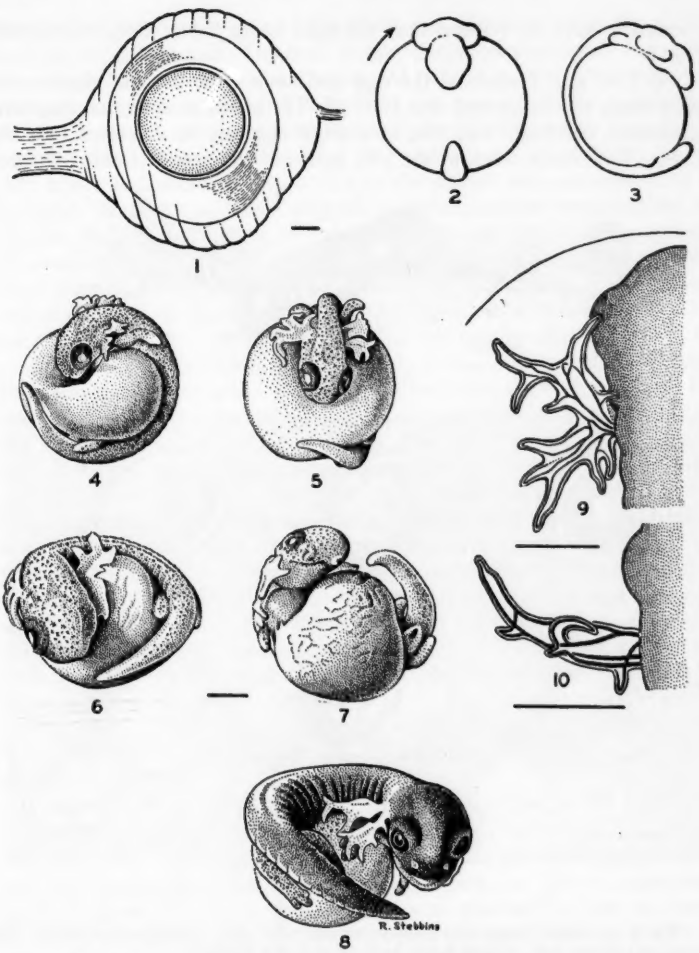

Fig. 1. The egg of *Batrachoseps wrighti* and stages in its development.

(1). Egg laid on June 1, 2 hours old. The connecting jelly strand had been torn away on the right. Concentric lammellae of the inner jelly layer are partially shown to indicate the presence of an inner differentiated zone of fine lammellae. This is shown in the drawing as a clear area. The transition from the coarse to fine lammellae was not as sharp as shown. Note the diagonal furrows in the outer capsule. The vitellus rather completely filled the vitelline chamber. (2) and (3). Embryo on July 13, at 41 days. Head and tail fold, limb buds, and anlagen of gills were present. The swellings on either side of the neck are rudimentary gills. The embryo rotated by ciliary action in a clockwise direction as indicated by the arrow. (4) and (5). Larva on August 6, at 65 days in two views. Gills were well-developed and melanophores had become widely distributed. (6) and (7). Larva of similar age (August 7). Note that the cardiac bulge is to the right in diagram (7). Oral, cloacal, and nasolabial grooves were present. (8). Larva on September 13, at 103 days. Note presence of digits, bipartite gills, nasolabial grooves, tongue, and eyelids. (9) and (10). Gill of 114-day-old embryo in dorsal aspect (9) and as viewed toward anterior surface (10). In diagram (10) the ventral surface of the gill is uppermost. Blood vessels are of capillary size except for several of the larger trunks. All vessels that were apparent on the dorsal surface of the gill are shown in diagram (9). A similar ventrally situated set of vessels was omitted from the drawing except for the ventral portion of the vascular loops in the finger-like lobes of the gill.

Size in all drawings is shown by the horizontal lines, all of which represent 1 mm. The line between diagrams (6) and (7) also applies to diagrams (2) to (5), and (8).

attenuatus have been found near the eggs under field conditions (Emmel, 1924).

At 2:35 P.M. I removed the eggs and adult from the cold room to my office where the temperture was 17.7° C. The higher temperature may have accelerated hatching. Hatching of a single egg may be described (see Fig. 2, B). The transparency of the jelly layers of the eggs facilitated observa-

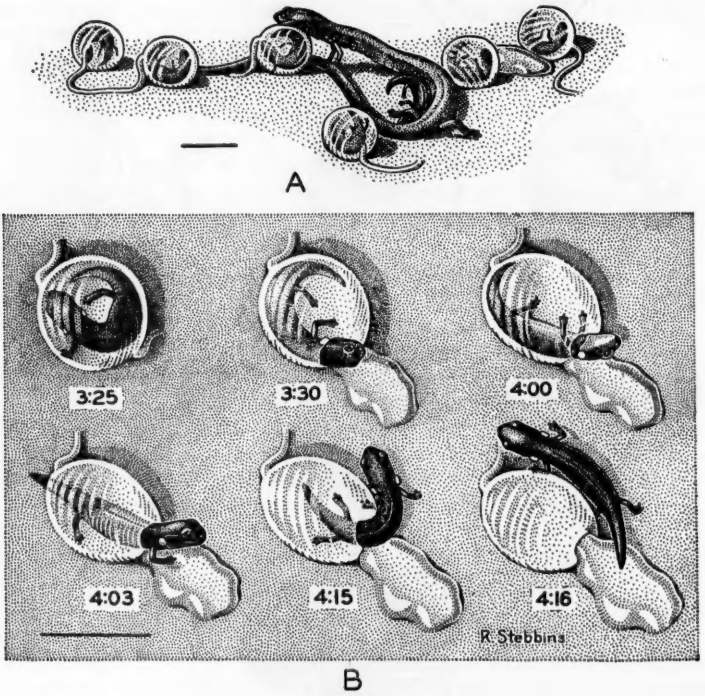

Fig. 2, A. Adult female *Batrachoseps wrighti* with eggs. Hatching had begun. One young was at her side. Several hours later all eggs had hatched.

B. Stages in hatching. Drawings were based on sketches made during hatching of a single individual. The time (p. m.) at each stage is indicated. Note the glob of jelly extruded upon rupture of the egg membranes.

The horizontal line in both sketches represents 10 mm.

tion. From 3:00 P.M. to 3:30 P.M. the larva periodically writhed about within the vitelline chamber. Periods of movement alternated with periods of quiescence. At 3:30 P.M. the animal curled and suddenly straightened out, appearing to strike the wall of the capsule with considerable force. This movement was followed by a spiral turning while the salamander directed its snout against the egg capsule near the attachment of the jelly strand. This movement was followed by rupture of the egg. The egg suddenly

flattened slightly and a glob of fluid jelly was discharged near the attachment of the jelly strand. The head of the salamander protruded. For about 10 minutes the animal did not move. At 4:00 P.M. the salamander had twisted over on its back and had its head and neck out of the membranes. At 4:03 P.M. the fore limbs were free and the tail had broken through the opposite side of the egg, suggesting that considerable deterioration of the jelly layers had occurred. At 4:15 P.M. the animal had extracted itself to its waist. At 4:16 P.M. it had escaped. Forty-six minutes were required for eclosion, following rupture of the capsule. All the eggs but one broke opposite the head of the imprisoned salamander so that the animals were expulsed head foremost. Some enzymatic substance may be liberated in the cephalic region that aids in the dissolution of the egg capsule. Noble (1931: 131) mentions unicellular glands functioning in this manner that appear on the snout of tadpoles and probably all urodele larvae, shortly before hatching. One individual in my series, however, was projected outward tail first. For over 15 minutes this individual periodically struggled to get through the egg membrane. It continually strove to move forward despite the fact that half its body projected beyond the opposite side of the capsule. The capsule at last gave way under the continuous probing and the salamander escaped. During hatching of the eggs the female crawled about among them. Twice she nosed emerging young. Once she nosed a young animal only the head of which was protruding, slid her chin along its neck and pushed the capsule half way along its back. Since this was observed only once, the action was probably accidental. By 4:23 P.M. all the young had hatched. Fifty-three minutes had been required for hatching of 6 eggs. This corresponds rather closely with the time required (46 minutes) for the hatching of the individual whose emergence was described.

The nearly simultaneous emergence of all the young suggests that the thermal change in moving the eggs to a warmer environment may have stimulated hatching.

The recently hatched young measured from 13.3 to 13.9 mm. from snout to posterior margin of the vent and from 18.7 to 19.6 mm. in total length. The young had surprisingly short tails in relation to the tail length of adults. All were almost solid black above with a scattering of silvery guanophores most abundant dorsally in the area that was expected to form the dorsal stripe of the adult. Pale bluish-white guanophores, consisting mostly of isolated cells, were present ventrolaterally in areas where the white guanophore clusters of the adults appear. The ventral ground color was sooty. All young had gill stubs. The remainder of the yolk mass largely filled the abdominal area of all individuals.

Summary

A female *Batrachoseps* (=*Plethopsis*) *wrighti* obtained 8.7 miles southeast of Sandy, Clackamas County, Oregon, deposited 11 eggs in the laboratory. She was induced to lay by implantation (during a 7-day period) of two *Hyla regilla* pituitaries. Her eggs were fertile despite the fact that no male had been present during a period in captivity of one month. The eggs were laid June 1 and 2 and hatching occurred October 13, 133 days

later. During the developmental period, the eggs were kept on a damp paper towel in a gallon jar in a darkened room at a temperature of approximately 12° C. The eggs were transferred to a clean jar and fresh paper towel once a week. Stages in development and hatching of the eggs are described.

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Notes on *Rana sylvatica* in the Labrador Peninsula

By HENRY HILDEBRAND

DURING the summers of 1947 and 1948, I was a member of a marine biological survey party working in Ungava Bay under the direction of Dr. Max Dunbar, of McGill University, and sponsored by the Fisheries Research Board of Canada. Fort Chimo, which is located on the east bank of the Koksoak River approximately 25 miles from its mouth, was chosen as the base of operations due to its proximity to an airfield.

In 1947 I arrived at Fort Chimo on June 14. A brief exploration of the surrounding tarns and streams revealed no frogs, nor were they expected so far north of their known range. Bob May, the Hudson Bay Company Factor at George River, told me that frogs occurred in that area. He had personally

never seen frogs, but had heard them calling and had been given good descriptions of frogs by the Eskimos. A search in the ponds and the streams in the general region of the George River post in late August was unsuccessful.

Inquiries among the Fort Chimo Eskimos revealed that frogs were not uncommon at Fort Chimo during May and June, but according to my informant, during July and August frogs would all be gone. On arrival at Fort Chimo after the end of the summer's work in Ungava Bay in 1947, a careful search was made on September 2 of a small pond on the Fort Chimo terrace with no results. The day was cloudy and cold which undoubtedly contributed to the lack of success. An early departure prevented further work in 1947.

On arrival at Fort Chimo in 1948, Eskimo boys were recruited and we visited a small pond on a rocky ridge about one-tenth of a mile north of Fort Chimo on June 18. The day was sunny but cool. I saw and captured one adult frog as it sluggishly attempted to disappear in the muck at the bottom of the pond. A very careful survey of the edges of the pond failed to uncover additional specimens. The adult frog obtained was 47 mm. in length.

Neklinyuk is the Eskimo name for the frog in this region. Etymology of the word is unknown to me. Eskimos are afraid of frogs, and under no circumstances would the majority of them touch a frog. To capture or disturb frogs is thought to cause bad weather, especially rain and fog. My frog capturing activity was not popular in the community, although the natives were co-operative in aiding me to locate frogs. A spell of bad weather in September was considered by nearly the entire village to be a result of my frog-catching activities. An interesting sidelight is that the rough-legged hawk, *Buteo lagopus,* is believed to share with the frog a propensity for making bad weather if its nest is disturbed.

A second adult frog was brought to me by Simeone Suppa, a native; he had caught the frog in a tin can and was not touching it. This specimen was 52 mm. in length, and is now in the National Museum of Canada along with the first specimen. No additional frogs were seen the remainder of the summer. Questioning the natives revealed that frogs are common during "Upernark Kasak" (almost summer) when most of the snow is gone and large pools of melt-water form. This season would be approximately the period between May 10 and the first week in June, which would put egglaying time before the break-up of the major streams and lakes. Break-up of the Koksoak is usually around June 7–10; the large lakes may have ice present until the first week in July.

Patch (1939) defined the northern limits of the wood-frog in Quebec, as represented by specimens, to be Charlton Island and Cape Hope Islands (near East Main), James Bay, Tadoussac, Quebec, and Natashkwan, Quebec. The closest of these localities to Fort Chimo is over 500 miles southwest of Fort Chimo. Packard (1866) obtained a single specimen of a frog from a Moravian Missionary at Okak, Labrador, in 1864. This locality is on the Atlantic coast approximately 300 miles east southeast of Fort Chimo. Native reports quoted by Packard (1866) would indicate that this species is not infrequently found south of Hamilton Inlet on the Labrador coast. Although L. M. Turner's manuscripts on the natural history collections made during

1882–4 at Fort Chimo fail to indicate the collecting of any frogs, he includes an Eskimo name for them in his list of Eskimo words compiled at Fort Chimo (manuscript, 1885). An inquiry concerning Turner's collection at the U. S. National Museum revealed that no frogs were deposited in the museum by him. This inclusion of an Eskimo name for a frog would indicate that the wood-frog has not recently extended its range into this locality.

On June 21, 1948, Philip Orkin, another member of the marine biological survey party, and I made a return visit to the pond where the adult frog was obtained on the 18th. This pond has a native name that means frog-pond, and it will hereafter be referred to by that name. Frog-pond is a permanent pond, approximately 100 by 50 yards and 3 to 4 feet deep. The bottom is composed of a mucky peaty soil, which makes wading extremely difficult. The color of the water is a peaty brown. Frog-pond is located approximately 10 miles from the northern limits of trees along the Koksoak, and is one of the hundreds of ponds and lakes that pock mark the region. East of the pond is a swampy valley area covered with sedges, mosses and in places larch, dwarf birch, alders and willows. Black spruce, once abundant, has been nearly eliminated by extensive cutting for firewood, and for flooring boughs in the natives' winter tents. The west edge of Frog-pond fronts on an almost barren gneissic ridge, which is so typical of this part of the Canadian Shield, and an outlet cuts across the southern part of the ridge, and drops precipitously to the Koksoak River. Only a trickle of water ran through this outlet in 1948, due to the extremely light snowfall of the previous winter.

Along the western part of the pond in water of a foot to 2 feet deep was an abundant matted growth of buckbean, *Menyanthes* sp. This was the chief distinguishing feature between Frog-pond and many other ponds in the region, though *Menyanthes* is not a rare weed in the area. Solid gneissic rocks were visible along part of the north edge of the pond. The east and south edge consisted of mucky peat with borders of sedge and sphagnum moss. Frog-pond is not at present shaded by tree or willow growth, nor is there evidence that such growth has been removed by human agency.

Snails, *Lymnaea palustris*, were extremely common in the pond. Caddis flies and dragon fly larvae were not uncommon. No fish were found, not even the ubiquitous sticklebacks so common in ponds and streams of the district. Only one water bird, probably a loon, was seen to rise from the pond during the infrequent visits in the summer of 1948.

On June 21, 1948, when wading along the waterward edge of *Menyanthes*, I found eleven globular balls of frog eggs attached to the plants about 4 inches below the surface. One cluster was attached to dead wood, a small larch tree, in the water. A nearly uniform state of development was found among all the egg clusters except one which was not as far advanced. Eleven clusters had larvae fully developed and on shaking the adhering gelatinous mass, they would escape and swim away. One cluster was preserved. It contained 540, 7 mm. tadpoles, and I estimated that over a hundred escaped in handling. Very few infertile eggs were observed, and only seven infertile eggs were counted in the cluster saved. The depth of water beneath the egg clusters varied from 1 to 2 feet.

Sealing activity in Ungava Bay prevented another visit to the pond before July 21. I obtained only one tadpole when I investigated a movement in the muck along the edge of the pond among the buckbeans. The lack of activity I attributed to a cool and overcast day. The following day I returned to the pond in the early afternoon when the sun was shining brightly. No tadpoles were seen among the *Menyanthes* but they were quite numerous over the rocky bottom on the north edge of the pond in about a foot of water. When disturbed they would immediately swim toward the bottom. Eight tadpoles obtained measured 21 to 28 mm. If I am right in assuming these are of the same age as the tadpoles that had emerged the previous month, they had tripled or quadrupled their size in exactly a month.

The next visit to the pond was not until September 2. One tadpole was obtained in the muck at the edge of the pond. All four legs were developed; its measurements were: total length 27 mm., tail 9 mm.

A trip to the pond on September 18, 1948, was unsuccessful in obtaining frogs, probably due to an overcast sky. However, on a return trip on September 20, 1948, a brilliant Indian summer day, small frogs and tadpoles were observed to be numerous. Small frogs were seen in the sphagnum moss along the edge of the pond. Most of them dived immediately for the muck at the bottom of the pond, but several were seen to swim on the surface of the water for short distances. Along the edges of the pond tadpoles in various stages of development were sighted and obtained. The following are the measurements and remarks on the frogs taken that day. Two small frogs with only a slight trace of a tail were captured, total lengths 17 and 19 mm. respectively; one frog 22 mm. total length, tail 6 mm.; one tadpole 31 mm. total length, tail 17 mm. and the hind and forelegs well developed; one tadpole with no foreleg development was 38 mm. total length, tail 19 mm. Two tadpoles were kept in a pan of water until October 4. One tadpole, which was captured on September 20, had only slight development of the hind legs, but by October 18, when it died, it had metamorphosed fully and only a slight stub of a tail was still present. This tadpole had been kept in water temperatures considerably higher than its native habitat; the last twelve days, when rapid growth was made, were at room temperature in the Biology Building at McGill University. This leads me to believe that this specimen would not have metamorphosed in its native habitat until the following summer, if it could survive the winter in the tadpole stage.

On the last visit to the pond, September 26, one tadpole was taken. This tadpole had well developed legs, but the tail had not begun to shrink. This specimen was kept alive until October 4.

Discussion

Growth rate of the tadpoles is no doubt to a large degree a function of temperature. The summer was warmer than average, but September was foggy with few bright days. One specimen nearly metamorphosed was obtained on September 2, and the first metamorphosed small frog was taken on September 20, 1948. Length at metamorphosis was found to be 16 to 19 mm. On the same date, tadpoles were taken in stages varying from weak

development of the hind limbs to strong development of all four legs, but with the tail still persisting. This condition persisted as late as September 26 when all observations ceased. One tadpole kept for one month after its capture on September 20 required that additional period to metamorphose at much higher temperatures than it would have experienced in its native habitat. No tadpoles, which might have passed the winter as tadpoles, were obtained in June, yet the stage of development observed on September 20, 1948, would indicate that not all tadpoles metamorphose the first summer.

The first killing frost occurred in the area during the last week of August in 1948. A semipermanent ice cover on the pond would not occur before mid-October, with the outlet freezing by the end of November. Unfavorable summer temperatures might result in the entire yearly tadpole population not metamorphosing in its first summer.

Frogs are rare in the region and have a place in the Eskimo superstition for that reason. Site and method of hibernation were unknown to the natives questioned. Especially noted was the absence of suitable rocks and logs in the area of Frog-pond. Ice depth on the large lakes in the Fort Chimo region was found by the writer to be from 3½ to 4 feet during March and April, 1948, so it may be that Frog-pond freezes to the bottom. Dr. Max Dunbar comments, in a personal communication, that the heavy suspension of shell particles might keep the mud fluid during the winter, and that the mud at the bottom of the pond seems the most likely hibernation site.

Acknowledgments

I wish to thank especially the following: Dr. Max Dunbar, of McGill University, for help and advice; Philip Orkin, who was my colleague on the 1948 summer trip and aided in gathering some of the data; Clyde L. Patch for suggestions; and Bob May, Hudson Bay Company Factor at George River, for his hospitality during my stay in the region. A special debt is owed the authorities at the U. S. National Museum and the American Bureau of Ethnology for permission to examine L. M. Turner's manuscripts.

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Notes on the Life History of the Salamander *Aneides aeneus*

By Robert E. Gordon and Richard L. Smith

ALTHOUGH the plethodontid salamander, *Aneides aeneus* (Cope), seems to be common in some localities, there are comparatively few records of its occurrence and no life history data from the southern portion of its range in the Southern Appalachians. It has been reported from only two localities in North Carolina, Highlands (Brimley, 1941) and Bat Cave, Chimney Rock (Weller, 1930), each based on the collection of a single specimen. There are single published records for western South Carolina and northeast Alabama (Dunn, 1926, and Brimley, 1941–43) and in Georgia it has been found at several localities in the mountainous region, notably Tallulah Gorge in Rabun County (unpublished data of the writers and J. C. Nicholls, Jr.). During the summer of 1948 we discovered two breeding colonies of this salamander in the Highlands, North Carolina region and were able to make measurements and life history observations over a period of about two months. The work was aided by the Ward Research Fellowship, awarded by the Highlands Biological Laboratory. We are also indebted to Miss Thelma Howell, Resident Director of the Laboratory, and Dr. Eugene P. Odum for aid and suggestions in the preparation of this paper.

The first group of breeding *Aneides* was found inhabiting a granite cliff near the Laboratory at an elevation of 4100 feet within the town limits of Highlands, which is located 10 miles north of the Georgia line on a high plateau of the Blue Ridge. This site, hereafter known as the Highlands site, was under observation from June 15 to August 20. Less extensive observations were made at the second site, a spectacular granite outcrop known as "Granite City," having an elevation of about 3100 feet and located about 10 miles southeast of Highlands in Jackson County, North Carolina (very near the common junction of North Carolina, South Carolina and Georgia).

Aneides aeneus has been previously recorded as inhabiting "the loose bark of dead trees" (Pope, 1928), limestone cliffs (Walker and Goodpasteur, 1941), sandstone cliffs (Bishop, 1943), and quartzite cliffs (Nicholls, personal correspondence). Thus to this list the authors add exfoliated surfaces and horizontal crevices of granite cliffs. The granite cliffs in the Highlands site were located in a mature hemlock forest with a rhododendron understory. Eggs, immature and mature individuals were collected from crevices which were so densely shaded as to require the use of a flashlight in finding the salamanders. The crevices admitted little or no water from surface run off, the heavy plant growth holding enough moisture to keep the atmosphere humid. The sites of the eggs within the crevices were moist but not wet. No specimens were found in crevices directly exposed to sunlight. A similar situation existed at the "Granite City" site. The depth of the crevices at both localities was quite variable.

The previous record from Highlands was an individual found August 1, 1938, by Dr. W. C. Coker in his woodpile, which incidentally was located a

short distance from the cliffs at our No. 1 site. Although we spent considerable time pulling bark off fallen logs and standing but dead trees at both localities, no specimens were to be found in this type of habitat (described as arboreal by Pope, 1928). Evidence presented by Walker and Goodpasteur (1941), together with our observations at Highlands and those of Nicholls (personal communication) in Georgia, leads to the conclusion that *Aneides aeneus* is essentially a cliff-dwelling form during the breeding season in the Southern Appalachians. It presumably resorts to arboreal or other residences where the cliff habitat is lacking or where crevices and moisture conditions are not suitable.

From the two localities, Highlands and "Granite City," a total of 22 specimens were taken and approximately 30 more were seen. The average total length of 15 mature individuals of both sexes from both localities is 11.7 cm. Seven specimens from the Jackson County site average 11.5 cm. (extremes, 12.4 and 10.6 cm.) and 8 from the Highlands site averaged 11.8 cm., (extremes, 13.8 and 10.3 cm.). A mature female from the Highlands location has seven functional toes on the left rear foot. The second and fourth in order of length appear to be doubled.

Between June 15th and 21st, a total of 12 clutches of eggs were located at the Highlands Station. The sites of the clutches were marked to facilitate observation. One clutch of 22 eggs was removed on June 15 and examined in the laboratory immediately. The majority of eggs in this set were in the two- to four-cell stage and none were beyond the blastula. Their averaage diameter (including the outer egg membrane) was 4.5 mm. All 12 clutches were attached by several strands of mucus to the tops of the crevices. There was little pigmentation in the eggs, the color being whitish yellow. The average depth of deposition of all clutches in the crevices was 5.4 inches. The deepest was 15 inches and the shallowest, 3 inches. Generally, the eggs were laid as far back in the crevice as its depth permitted. Nicholls (personal communication) reported eggs in Tallulah Gorge, Rabun and Habersham Counties, Georgia, 4 to 5 feet from the surface opening. His sites, while located in quartzite, are comparable as far as moisture and vegetation is concerned to those at Highlands.

The females, at all times, were lying either to one side of the clutch or with the body around it. At no time was a clutch found to be unguarded. No effort of defense was made by the females when the clutches were disturbed, the only action being that of attempted escape. No specimens (males, immature individuals or other females) were found in the same crevice with a clutch and guarding female, except once when 2 clutches, and accompanying females were found in the same crevice, separated by a distance of 9 inches. It was extremely difficult to count the number of eggs per clutch *in situ*, but 10 clutches collected averaged 19 eggs, the largest containing 23 and the smallest 12 eggs. Two clutches located under similar conditions at the Jackson County station contained 18 and 22 eggs respectively. The average temperature at 7 sites at Highlands for an 18-hour period (taken on the days of June 16 to 21) was 18° C, with little variation.

On August 20, 5 clutches which had been under observation since June at the Highlands locality were collected. All of these showed similar rates of development. The embryo was well formed and a large globule of yolk present. The authors were unable to make additional checks and, therefore, were unable to determine the exact time of hatching. However, it is to be noted that they existed under natural conditions in intra-oval life throughout the 66-day period of observation.

Occasionally specimens of *Plethodon shermani melaventris* and *Desmognathus ocrophaeus carolinensis* were found at Highlands in association with *Aneides* but never in the same crevice.

Thus *Aneides aeneus* in the Highlands, North Carolina region, and probably in the southern Appalachians in general, appears to be essentially a cliff dweller, at least during the summer breeding season, arboreal or other habitats being of secondary importance. The type of rock apparently is not a limiting factor, but its geological condition as to crevices, their depth and position appear to be important. Narrow horizontal crevices and niches from a few inches to several feet deep (average 5.4 inches at Highlands locality), moist but not wet, and well shaded by mature or dense forest vegetation appear to provide optimum conditions for breeding. Mature adults averaged 11.6 cms. (22 collected); clutches averaged 19 eggs (12 collected). The clutches were always suspended from the top of the crevice by several strands of mucus and were always found guarded by the female. Eggs were in early segmentation stages June 15–20 when first found, and under the low temperatures prevailing in the natural habitat (average 18° C. in June) were still unhatched at the end of observation, August 20, a period of at least 66 days intra-oval development.

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Observations on the Habits of the Horned Lizard *Phrynosoma m'callii*

By Kenneth S. Norris[1]

DURING June and July of 1948 the little known horned lizard, *Phrynosoma m'callii* (Hallowell) was observed in the sand dune area between Palm Springs and Thousand Palms Junction, Riverside County, California. In this region the Coachella Valley narrows to a width of approximately 7 miles. Ten miles to the northwest the valley becomes confluent with San Gorgonio Pass, which rises from the desert floor and leads out onto the California coastal plain.

The valley floor in the study area bears sand hummocks of white, fairly fine, aeolian sand, topped by creosote bushes (*Larrea divaricata*). While creosote bush is the dominant perennial, burro weed (*Franseria dumosa*) and *Dalea Emoryi* are also abundant. A composite, *Dicoria canescens,* is also common but is generally small and does not form the nucleus for large sand accumulations. The area is one of extreme aridity. The mean annual rainfall recorded over a sixteen-year period at Palm Springs is 5.6 inches (Sprague, 1941). The study area is at an elevation of from zero to 45 feet above sea level. Air temperatures are very high in the summertime, often reaching 46° C. (115° F.) in the shade. A series of temperature readings taken on a typical sand hummock for a full day showed that all the surface sand, including that in the shade of creosote bushes, was in excess of 55° C. (130.5° F.) by 1:00 P.M. These readings were taken on July 14, 1948.

The morphology of *Phrynosoma m'callii* and some of the following observations indicate that it is primarily an arenicolous form. None of the specimens observed were collected outside areas of shifting sand. To the east of Thousand Palms this lizard was taken in an area of sand hummocks interspersed with stretches of gravel. This is probably a marginal situation.

The covered tympanum and the dorso-ventrally flattened tail and body seem to be adaptations for "sand swimming." Stebbins (1944) has correlated the sand swimming habit with body form for *Uma*. On two occasions these lizards were sighted along the long lee slopes of sand hummocks. Both times the animal turned and ran down the slope away from the observer and swam into the sand. They were located by tracking. The lizards apparently dove into the sand while in full flight as they were found buried about 4 inches beyond the point of entry into the sand. This short swim parallels that of the majority of swims shown by *Uma*. Whereas the shovel-shaped snout of *Uma* may be adapted to sustained sand swimming, the blunt snout of *P. m'callii* seems poorly adapted to continuance of swimming once initial momentum is lost. The conclusion that true sand swimming probably does not take place to any extent in *P. m'callii* after the loss of momentum seems

[1] The author wishes to express his appreciation to Dr. R. B. Cowles and Mr. Charles H. Lowe Jr. for critical review of the manuscript and to Mr. R. G. Zweifel and Mr. William Bittle for assistance with the field work.

supported by the statement of Klauber (1939): "Like many species of horned toads they [*P. m'callii*] usually spend the night just below the surface of the sand. They cover themselves by violent wriggles, without going forward."

The proximal prebrachial scales, the pretibial scales just below the knee, and the posttibial scales just above the heel are more pointed and more strongly keeled than other limb scales. This is also true of *Uma*. Stebbins (*ibid.*) states that these surfaces facilitate submergence in *Uma*. It is extremely likely that they serve the same function in *Phrynosoma m'callii*.

Phrynosoma m'callii is capable of quite rapid locomotion, and if one gets only a short glance of the running animal it can sometimes be mistaken for *Uma*. Its spurts never seem to be continued for as great distances as those of *Uma*. The longest run observed was approximately 50 yards. At the end of these runs the animal either (1) swims into the sand, or (2) crouches down until its head and body are tightly pressed against the sand. If the latter course is taken the remarkable protective coloration makes the animal almost invisible. The course taken is probably dependent upon the closeness of pursuit and the surface temperature of the sand. In either case, usually, the lizards may be picked up by hand, so "reliant" are they upon concealment. Twice individuals have been found partially buried in the sand with only the head and the center of the back exposed. These animals had not been previously frightened and made no attempt to move until after they had been grasped.

Concerning the relative abundance of lizards, Klauber states: "Probably the rarest in San Diego County are *Eumeces gilberti rubricaudatus* on the coast, and *Phrynosoma m'callii* on the desert." In the area in which this study was carried out, the capture of *Phrynosoma m'callii* was not a common occurrence. If two specimens were taken in a day the collecting was good. However, considering the exceptional protective coloration, sand swimming, and speed demonstrated by this lizard, it is my opinion that in the area of study the animal is fairly common. Most of the specimens collected were taken by driving slowly over the macadem road between Thousand Palms Junction and Palm Springs. These horned lizards, along with *Uma inornata, Dipsosaurus d. dorsalis,* and *Callisaurus d. gabbii,* were found resting on the road or walking across it. The white color of all these lizards contrasts strongly with the black of the road, so they could often be sighted 100 yards ahead of the car. The best hours of collection were from 7:00 to 10:00 A.M. Earlier in the spring, before midday temperatures have become so high, the period of successful collection might be expected to extend over a larger portion of the day. During the month of field collecting in which the data of this report were gathered, *Phrynosoma m'callii* was found to have the longest diurnal range of any of the thirteen species of lizards collected. Both the earliest and latest records were specimens of *P. m'callii*. One individual was taken at 7:00 A.M. resting on the lee slope of a sand hummock in direct sun, and another was taken at 10:25 P.M. lying very closely pressed to the pavement one-half mile east of Thousand Palms Junction. Klauber (*ibid.*) mentions a record of this species having been taken at 8:00 P.M.

Temperature Relations

Eight temperature records are available for this species. These are presented in Table I.

Table I

Record	Date	CT	AT	ST	Time
1.	5/15/48	37.0 C	—	—	10:45 A.M.
2.	7/8/48	39.2 C	37.2 C	38.2 C	8:45 A.M.
3.	7/8/48	31.8 C	31.4 C	31.8 C	10:25 P.M.
4.	7/9/48	40.2 C	37.5 C	41.0 C	9:25 A.M.
5.	7/10/48	35.2 C	34.1 C	34.0 C	7:00 A.M.
6.	7/10/48	39.5 C	35.0 C	38.0 C	8:15 A.M.
7.	7/12/48	39.5 C	35.0 C	38.0 C	9:45 A.M.
8.	9/27/48	37.5 C	31.5 C	35.0 C	1:50 P.M.

CT = Cloacal Temperature
AT = Air Temperature (at 1 cm. above the surface of the soil at the point of capture).
ST = Soil Temperature (the bulb of the thermometer was barely covered with soil at the point of capture).

The range of five degrees between extremes of cloacal temperature may represent approximately the optimum temperature range of *Phrynosoma m'callii*. The night record (No. 3) was not included in Figure 1 as such nocturnality is surely somewhat aberrant for the species. Records (1) and (9) are not included in Figure 1 because they were obtained at different seasons than the remaining data. Even considering the meagerness of the data available it is felt that future records will follow approximately the same relationships shown in Figure 1. It can be seen that cloacal temperatures correspond more closely with soil temperatures than with air temperatures (Fig. 1) and that, in general, cloacal temperatures are slightly higher than substrate temperatures until maximum body temperatures are reached. It seems apparent that substrate heat and direct insolation rather than heat from the surrounding air is principally responsible for the body temperature of a basking lizard. The body form of the animal would facilitate aquisition of heat in the manner indicated by these data. The 10:25 P.M. record shows that the animal obtains heat from the substrate at this time. The animal's flattened position at the time of capture supports this view.

In *Phrynosoma m'callii* temperature control is carried on in part by orientation of the body toward the sun or substrate (Cowles and Bogert, 1944). In the early morning these animals are most often found on the sunny side of the long stringers of sand located on the lee side of sand hummocks. This orientation is probably maintained until the animal's temperature enters its optimum range. Once the animal achieves this range it commences to move about, orienting itself now and then to recoup its thermal supply. As the day becomes warmer, these lizards may be seen perched on rocks or sand hummocks, usually with their heads facing the sun. This places the relatively broad expanse of their backs out of the direct rays of the sun. At this time the animals are most often seen with their bodies raised well above the substrate. Sometimes, when temperatures reach this level, the animals bury the

main part of their body below the torrid surface layer of sand, thus taking advantage of the cooler sand below. Cowles (1945) has described this same phenomenon for the sidewinder, *Crotalus cerastes*. By the time the coolest of the surface sand reaches 43° C.– 44° C. all of the reptiles of the dunes have retreated underground. *Phrynosoma m'callii* apparently retreats somewhat before this, probably when lowest temperatures are around 41° C.

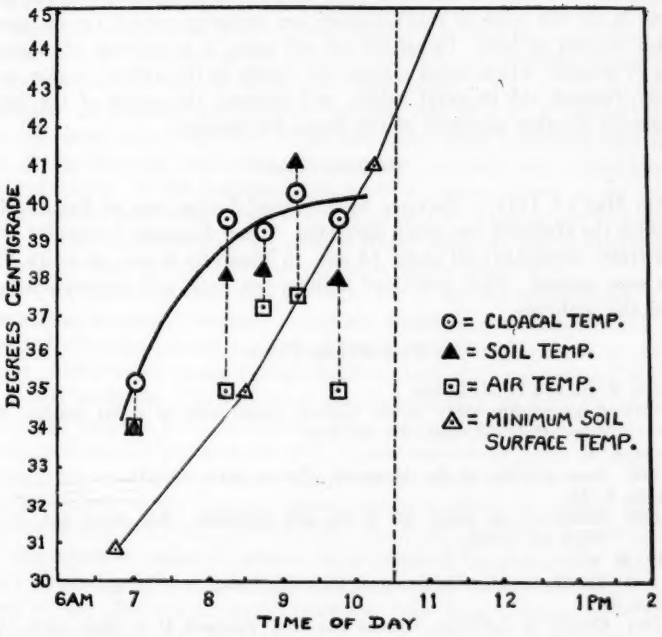

Fig. 1. Temperature relations of *Phrynosoma m'callii* for July. The vertical dotted line at 10:30 A.M. represents the latest time during July at which a daytime observation of *P. m'callii* was recorded. Minimum soil surface temperature was determined as a part of a day long temperature survey of a typical sand hummock. Records were taken at fifteen stations around the hummock. The figures used are the lowest figures obtained on the surface of the sand at any of the stations. The line has been continued past the 10:00 A.M. reading on the basis of a 1:00 P.M. minimum reading of 55° C. Sunrise was at about 6:00 A.M. during July. The 9:45 A.M. readings were taken on a cool day. See text.

Food Habits

Phrynosoma m'callii seems to be singularly restricted with regard to diet. Of four stomachs examined all were filled solely with ants. Van Denburgh (1922) says: "Specimens were secured on sand hills east of Yuma. They

eat ants. One was found sitting on an ant hill, but not an ant was in sight although a half hour later they were swarming over it. It seemed as though the ants remained under cover in the nest as long as the lizard was watching them."

Parasitism

All of the four animals examined were rather heavily parasitized with nematodes. The limited nature of their diet seems to indicate that the other stages in the life cycle of this nematode are probably carried by the species of ant utilized as food. Parasitism by red mites is a common phenomenon with *P. m'callii.* These mites concentrate chiefly in the axillary region, gular region, beneath the occipital spines, and between the scales of the lateral fringes, as in other members of the genus *Phrynosoma.*

Reproduction

On May 15, 1948, a specimen was captured 2 miles east of Palm Springs in which the abdomen was much distended. When dissected it revealed seven eggs (fully developed) all about 14 mm. in length by 8 mm. in width. The eggs were opened. They contained nothing but fluid yolk material without detectable embryos.

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Dark Coloration in the Reptiles of the Tularosa Malpais, New Mexico[1]

By Thomas H. Lewis

In 1932 Bradt described the mammals of the black lava Malpais of the Tularosa Basin in New Mexico and noted the close approximation between the colors of the animals and of the surrounding rocks. In the same year Benson described several new dark colored rodents from the lava, and Dice and Blossom in 1939 summarized the relationships between soil and pelage colors in the mammals of this and numerous other areas of the desert southwest. The latter authors demonstrated the general rule that dark colored forms were correlated with dark soils, while pale forms were correlated with light soils. In the Malpais, they found five species of mammals that tended toward dark coloration. In the contiguous snow-white gypsum dunes of the White Sands National Monument, they noted three species of mammals with pallid pelage tones. In less distinctively colored areas, mammals tended to approach the reds, yellows, buffs, and browns of their native substratum.

Smith (1943) has described the pale lizards of the White Sands (*Uta stansburiana stejnegeri* Schmidt, *Sceloporus undulatus consobrinus* Baird and Girard, *Holbrookia maculata ruthveni* Smith, and *Cnemidophorus perplexus* Baird). Color notes on the reptiles from adjacent "normal" colored regions are readily available. The reptiles of the Malpais have not been studied, and in order to examine their colorations, three collecting trips were made across various portions of the lava in 1948. Color notes were made in the field. Comparative studies were made, largely, from preserved material.

The Malpais of the Tularosa Basin consists of about 120 square miles of recent vesicular dull black lava extending north and south in a narrow irregular strip about 44 miles in length. It is bordered by arid plains and hills which determined the shape of the flow and which now bear the flora and fauna of the Chihuahuan biotic province. The lava is exceedingly rough and almost impassable. In places it is 50 or more feet in thickness. The surface displays such features as secondary terraces, collapsed bubbles and flow channels, pressure domes, knife-like ridges, extensive crevasses, crumpled and up-thrust extrusions, pahoehoe formations, cinder cones, and at the northern end a low crater. The surface is weathered but little. Enough glassy edges remain to damage even the heaviest boots. The violent winds of this part of the continent have buried the northern toe of the beds in drifted sand and loess. They have also carried into the lava sufficient pockets of soil to support a sparse growth of desert plants. In the northern portions (elevation about 5300 feet) ephydra and small junipers dominate. Farther south the more prominent large plants are mesquite, cholla, prickly pear, sotol, lecheguilla, atriplex, and near Malpais Spring (4150 feet) at the southern end of the beds, large *Allenrolfia* shrubs.

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[1] Thanks are due Dr. James B. Slater and Dr. Murray L. Johnson, College of Puget Sound, for their aid in the identification of the *Bufo*, and for critical reading of the paper.

Collecting was poor in all sections traversed. In the main, the relatively meagre herpetofauna seems to be a reflection of the scanty food supply. In part, however, the excellent concealing coloration of the lizard population and the rough, fissured, rock reduced the efficiency of the collector. The following forms were obtained:

Uta stansburiana stejnegeri Schmidt.—One male specimen was captured (No. 242). Morphologically it is similar to the utas from the adjacent desert. It is very much darker in color. The dorsal ground color is black, with scattered pairs and trios of bright turquoise blue scales. On the nape are a few orange and brown scales. The plates of the head are dark brown or black. Many of the dorsal tail scales are irregularly marked with white or gray. Several pale blue bars pass vertically over the lateral surface of the body. The thoracic spot is black. The belly and chin are dark blue with a black suffusion. The ventral surfaces of the limbs and tail are a lighter blue.

Sceloporus undulatus tristichus Cope.—These large, wide-bodied lizards were the most common reptiles in the Malpais. They were very difficult to capture or shoot because of their habit of diving into the nearest fissure or crevasse as soon as startled. Four adult females (No. 245, 247, 248, 256) and one juvenile male (No. 250) were collected. The dorsal color of these is dark brown to black. The dorsal "light" stripe is dark gray to dark brown. The dorsolateral stripe is light gray and more easily seen. The lateral white stripe, extending posteriorly from the axilla, is also usually distinct. There is an ill-defined series of black dorsal blotches on either side of the midline. The ventral surfaces are suffused with black to an almost uniform gray tone, except for the blue gular patches and a narrow blue line from axilla to groin.

The average measurements of the females are: body length 68 mm., tail 99 mm., dorsal scales 43, scales around mid-body 47. The male is a juvenile of 29 mm. body length. The tail is missing. Scales around the body number 45. Smith (1946) states that "Darker colors are the rule in this race." The lava specimens are much darker than other members of the genus from the adjacent desert but no specimens of ***tristichus*** were collected other than on the Malpais.

Crotaphytus collaris baileyi Stejneger.—Notes on a large specimen (No. 151) are as follows: snout-vent length 112 mm., tail 208 mm., head length 40 mm., snout to anterior edge of ear 31 mm.; dorsal color black, with small 1–2 mm. white spots evenly spaced 3 mm. apart over the body, dorsum of thighs, and proximal one-half of tail; posterior nuchal collar edged with these spots, which here are larger and more closely placed; scales of head dark brown; two pronounced black collars; chest, lateral belly, and mid-part of throat black; ventrum of thighs, arms, and forearms gray, sifted with sooty black; mid-belly and tail gray; lateral portions of throat with large, round, closely spaced black spots, this spotting extending around neck anterior to collars; scales of the head are large and rough; canthal scales pitted.

Two smaller specimens (No. 243, 246) are similar in color. Like a series from the southern part of the Tularosa Basin, these have three or more rows of scales between the supralabials and infraorbitals. The dark coloration of

the collared lizards from the Malpais contrasts sharply with the lighter tones of the southern series.

Cnemidophorus gularis octolineatus Baird.—Two small specimens (No. 153, 249) were obtained, in which the black ground color and pattern did not differ significantly from that of a series collected in the neighboring desert.

Crotalus molossus molossus Baird and Girard.—Two specimens (No. 254, 257) were collected, and compared with four individuals from the Organ Mountains. They are very noticeably darker. The ground color is dark greenish gray instead of greenish or yellow-gray. The dorsal blotches are black instead of dark green, but show the usual lighter central and bordering scales. The lateral black bars are two scales wide instead of one. All markings are less distinct in the posterior one-third of the body. The tail and proximal rattle are jet black. The ventral surface is white, indistinctly blotched with gray. No significant morphologic differences were noted between the two series.

In the Tularosa Basin *Crotalus molossus molossus* generally inhabits rocky places in the foothills and mountains. The lava occupies the lowest levels of the valley, however, and the above specimens appear to represent a variation in altitude preference, as well as in color. Since *molossus,* wherever found, is darker than other species of the same territory, one may speculate on whether melanic specimens enter the black lava terrain because of an advantage in the matching environment, or whether they are darker because they occupy a dark environment.

Pituophis catenifer affinis Hallowell.—One specimen (No. 255) was examined. Most of the dorsal and lateral blotches are quite black, a few of the dorsal blotches in the mid-body being dark brown with black edges. There is a brownish to blackish suffusion of the ventral surface. In these particulars the snake differs from others collected in adjacent terrain, in which the blotches are reddish brown or brown, and in which the abdomen is lighter.

Sonora semiannulata blanchardi Stickel.—One 261-mm. specimen (No. 251) was dug out from loose lava blocks. The tail length is 61 mm.; ventrals 150; caudals 56; scale rows 15–15–14, internasals 2; supralabials 8, dorsal ground color greenish yellow to brown, each scale with a large central black spot; orange-red dorsal stripe, brighter and broader posteriorly; head scales blackish to gray, edged with orange; belly pale gray-green and unmarked. No specimens were obtained for comparison.

Bufo cognatus Say.—One small toad (No. 252) was captured at Malpais Spring. The water is almost a saturated solution of calcium sulphate and other salts, a surprising place to find an amphibian. In these pools of crystalizing gypsum large numbers of an undescribed species of *Cyprinodon* are also to be seen.

Summary and Conclusions

Reptiles of seven genera and one amphibian were collected in the Tularosa Malpais. Most of the reptiles, as has previously been shown to be true in the mammals, tend to be colored like the black substrate on which they

live. It is postulated that this darker coloration is protective, that it is advantageous in natural selection, that it probably is a genetic rather than a transitory phenomenon, and that the differences other than coloration are insufficient, in the forms studied, to justify description of new subspecies. No qualitative differences in coloration were noted with variations in incident light or variation in temperature, which agrees with Klauber's (1939) observation that protective coloration precedes thermostatic coloration in importance. The specimens may be seen at the Puget Sound Museum of Natural History, College of Puget Sound, Tacoma, Washington, and are referred to, in the preceding paragraphs, by the field numbers.

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White Sands Proving Grounds, Las Cruces, New Mexico.

Sexual Differences and Normal Protogynous Hermaphroditism in the Atlantic Sea Bass, *Centropristes striatus*

By Nathan Lavenda [1]

IT has long been known by commercial fishermen that the male of the common Atlantic sea bass, *Centropristes striatus* (Linnaeus), reaches considerably greater average and maximum sizes than does the female. In a study of the life history of this species from early 1945 to the summer of 1947, it was revealed from scale-age data that the male also has greater longevity, apparently about twice that of the female.

Relatives of the sea bass possess unusual gonadal structures; male and female components being found in the same lobe and functioning simultaneously to produce sperm and eggs. This condition is not known to occur in other groups except as an abnormal or "teratological" condition. Cavolini (1792), reviewing the observations of ancient authors, ascertained that *Paracentropristis cabrilla* (Linnaeus) and *P. scriba* (Linnaeus) were hermaphroditic, the ovary containing a lobe which to all appearances was milt. He was of the opinion that in these species and in some others of the same genus the fish fertilize their own eggs. Duffossé (1856) confirmed the work of Cavolini and specifically suggested self-fertilization. Syrski (1876) showed that *Paracentropristis cabrilla* and *Sparus aurata* Linnaeus are both hermaphroditic. Brock (1878) concurred with Duffossé. Of the Mediterranean species, van Oordt (1929) sectioned histologically *Paracentropristis scriba, P. hepatus, P. cabrilla* and *Diplodus vulgaris* (Geoffrey St. Hilaire) which he showed to be invariably hermaphroditic, while only a considerable percentage of *Diplodus annularis* (Linnaeus) showed this condition. From his photomicrographs and discussion it is evident that the monoecious forms have gonads in which both sexual components are to be found in the same lobes. The female portion extends throughout the entire structure with the male portion generally distal to the gonoduct and at the periphery. Dantchakoff (1936), describing the histogenesis of hermaphroditism, specifically mentioned these European serranids. Van Oordt (1933) sectioned the gonads of several close relatives of *Serranus* (i.e., *Epinephelus, Plectropoma* and *Anyperodon*) from the Java Sea. The incidence of hermaphroditism was observed to be extremely high. On the American side of the Atlantic the serranids of the Tortugas, Florida, exhibit evidently functional hermaphroditism, according to Longley and Hildebrand (1940, 1941). In *Prionades nigropunctatus* Hildebrand mature eggs were found in the same structure with male tissue. In a single specimen of *P. phoebe* (Poey) immature eggs and a few motile sperms were found in the male portion. The genus *Serranus* here contains at least one hermaphroditic form, *Serranus tortugarum* Longley. Longley was also of the opinion that functional hermaphroditism exists in the genus *Hypoplectrus*. Kinoshita (1936) described a case of normal pro-

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tandrous hermaphroditism in a member of the Sparidae, *Sparus longispinus* (Temminck and Schlegel). He illustrated the changes occurring in the entire process by a series of photomicrographs. From the literature it is apparent that the vast preponderance of the true hermaphrodites which have been described among teleosts belong to the Serranidae, while a lesser number belong to the Sparidae.

After a considerable number of possibilities were considered it became apparent that only some form of sex inversion could account for the unusual size differential and age distribution of the sexes in the sea bass. This view was suggestively strengthened by the cited evidence that various close relatives of the sea bass are functional hermaphrodites. On the other hand the vast majority of the teleosts are fully dioecious. This study thus became an investigation to attempt to corroborate, by histological means, what was suggested by the statistical data and the literature, that this species may well be hermaphroditic.

The author acknowledges the close co-operation of the sea-bass fishing industry of Cape May, Barnegat, and Atlantic City in New Jersey, and Freeport and Baldwin in New York, for the collection of summer field data. For the gathering of winter observations Captain Joseph Lucas of the *Thomas J. Carroll* of Gloucester, Massachusetts, and Captain Patrick Norcutt of the *Whaling City* of New York City, made equipment and space available aboard their vessels on regular offshore fishing trips.

The research reported was performed in consultation with Dr. Charles M. Breder, Jr., Curator of Fishes, American Museum of Natural History. The histology was performed at that institution.

Materials and Methods

During the summers of 1945 and 1946 periodic trips were taken to representative points along that part of the Atlantic coast between Freeport and Baldwin, New York, and Atlantic City, Barnegat, and Wildwood-Cape May, New Jersey. In the study of the inshore spawning populations, samplings were taken aboard regular commercial skiffs in the course of normal fishing operations. Observations on the fish were made as the sea-bass pots were emptied of their catch. Approximately 6000 fish were thus examined. Scale samples were taken when feasible so that the age composition of the samples could be obtained.

As the summer advanced and the fish moved farther offshore, the fishermen followed them as far as was practicable for small skiffs. By early October the bulk of the population has gone beyond the range of these so-called "pot boats," and craft capable of fishing farther offshore are then brought into play to follow this moving sea-bass population. Several trips were made on these craft to follow up on the summer observations. In the middle of January large trawlers make two-week trips to catch these fish in their winter habitat on the rock bottoms near the edge of the continental shelf in the latitude of Chesapeake Bay. The fish were observed on these grounds in early February, 1946 and 1947.

Opportunity was afforded the author to make cursory observations of

specimens from the shores of Florida. Some 800 sea bass, shipped from that region to the Fulton Fish Market, were examined.

During the years 1945, 1946 and the early part of 1947 over 5000 scales for age determination were collected. Scale samples were taken from the region under the left pectoral fin. The length, the sex, the weight and the stage of gonads were recorded with each specimen. After cleaning by the usual methods, impressions on 3- by 5-inch celluloid sheets were made by pressing the mounted scales to the softened surface in a steam press.

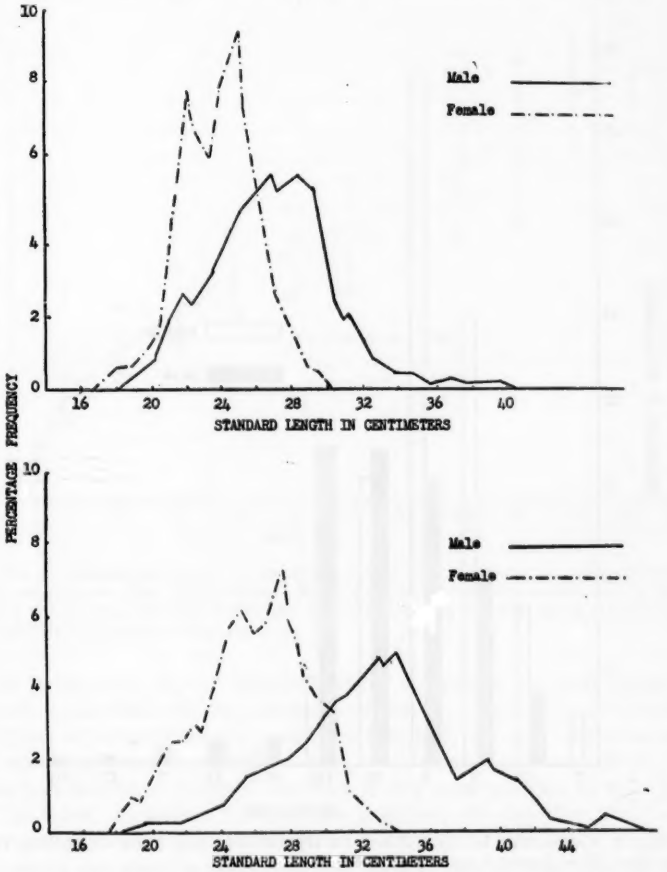

Fig. 1. Length-frequence distributions of representative summer populations of sea bass. *Upper*: from Cape May, New Jersey, June, 1945; 323 males and 252 females. *Lower*: from Cholera Bank, New York, June, 1945; 268 males and 221 females.

The gonads used in this investigation were obtained the first week of February, 1947. The sea bass spawns from the middle of May to the end of

June in the waters of New Jersey. The gonads were fixed in Bouin's solution in the field. On return to the laboratory the specimens were transferred to 70 per cent ethyl alcohol *in situ*. The actual dissection of the gonads and associated parts from the surrounding tissues was made just prior to the dehydration process. All gonads were sectioned at 7 microns, stained with Harris' hematoxylin and counterstained with eosin. The gonads of ten fish were sectioned. The individual ages of these same ten fish were determined from scales.

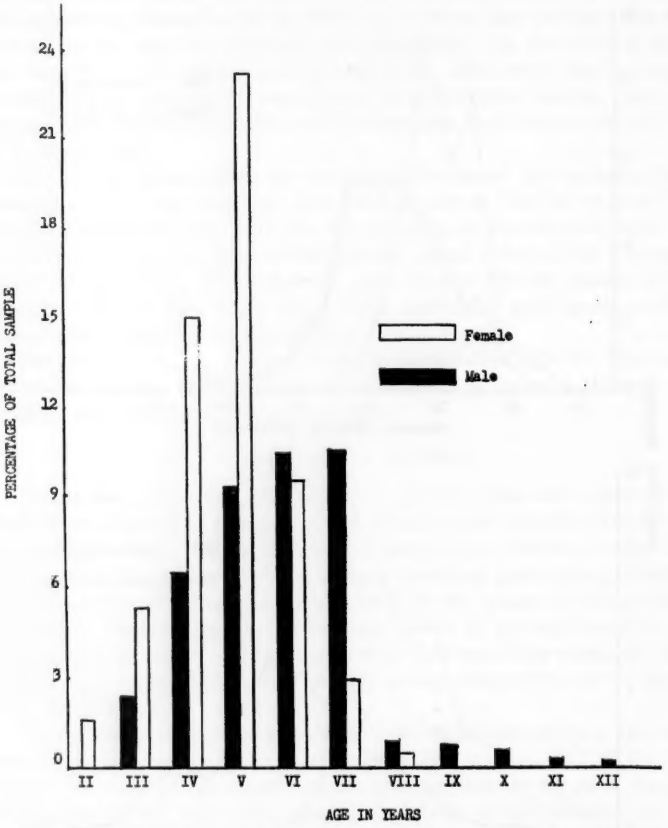

Fig. 2. Composition by age and sex of a representative population of sea bass, from Cape May, New Jersey, August, 1946; 512 fish.

Discussion

Little difficulty is experienced in determining the sex of the sea bass, since there are a considerable number of external morphological differences. It was noted early in our observations that fishermen are able to sex sea bass

accurately even when the fish are not spawning. The consideration of body shape apparently figures prominently in their estimation of sex. The female is sleeker and more graceful, with a more pointed snout than the male, and has a narrower caudal peduncle in relation to general body outline. In animals having the longer, exserted, upper caudal this structure is usually longer in the male. This is not a very useful indication, for in most fish caught commercially this streamer is broken.

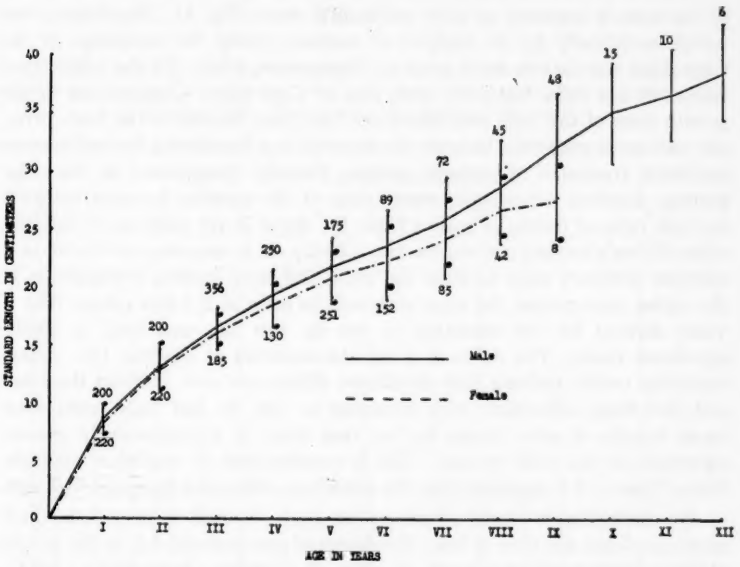

Fig. 3. Length-age curves for the two sexes of sea bass, based on 2339 specimens from the southern New Jersey shores. The lengths at year I were determined by scale reading of two-year-old fish. Twice the standard deviation for each sex is indicated by vertical lines and points along the lines.

In males over 25 cm. standard length an adipose occipital hump is formed concomitant with the seasonal development of the testes. This begins to appear in some specimens as early as February, although spawning does not take place until the middle of May. This development may persist for some time following spawning and there is still some evidence of it as late as September. In females this structure is absent, although there may be a slight protuberance in the area where the hump appears in males. The hump is generally not found in males under six years of age, although they may be sexually mature. The physiological significance of this hump is not known.

Figure 1 shows the summer distributions of sizes in regard to sex, where sex determination was based on secondary characters and stripping.

The rate of growth by sex of this species was determined by scale analysis. The annuli on the scale, taken to represent the winter seasons and thus

indicating the age of the fish, show up clearly. An annulus in the sea bass is formed by the bunching of the line configurations or circuli, forming a dark band about the scale. As the fish grows older and is laying down these annual year marks, there is a tendency for the annuli formed in the first and second years to become somewhat indistinct. These faint configurations were definitely ascertained as true annuli by the study of the scales of one- and two-year-old fish.

From inspection of the growth rates by sex, separation between the sizes of the sexes is apparent as early as the fifth year (Fig. 3). Significance was tested statistically by an analysis of variance, using the samplings of the Cape May populations for August and September, 1945. All the other tabulations do not differ markedly from that of Cape May. Comparisons in the growth rates of the male and female sea bass were limited to the four-, five-, six- and seven-year-olds, because the material was insufficient for satisfactory statistical treatment of younger groups. Females disappeared in the older groups. Random sub-samples were taken of the samples in order to get a uniform ratio of female to male (Table I). Since in the analysis of variance using Fisher's method (after Snedecor, 1940), it is necessary to maintain a constant arbitrary ratio between the sexes, and since females predominate in the earlier year groups, the ratio of female to male of 2:1 was taken. The F value derived for the variation of sex on 159 fish was 54.5, a highly significant result. The value of F for the variation of age was 133. These statistical results indicate that significant differences exist between the sexes and that these differences vary according to age. It had been noted from mean lengths of year classes by sex that there is a progressively greater separation in the older groups. This is corroborated by statistical analysis. From Figure 3 it is apparent that the sexual size difference increases with age.

No distinction in sexual coloration has been observed in those fish which have completed one year or less. Specimens of one-year-old fish at the height of the spawning season showed no signs of maturity. According to Hildebrand and Schroeder (1927), sea bass when a few months old and 2 to 3 inches in length possess a brownish color with a darker brown or black lateral stripe from eye to base of caudal. The sides are frequently marked with indefinite dark crossbars. There are red markings below the eye. The spinous dorsal fin is dusky, occasionally with a dark spot at the base of the posterior spines. Brick-red spots forming three or four rows are found on the soft dorsal fin. Reddish markings occur on the caudal and anal fins, the pelvics being plain and the pectorals salmon.

Prior to leaving the shore waters, the fish which spawned in the spring of the year have been observed to turn a grayish blue with the dark band still prominent. Some of the fish are somewhat browner but this is apparently not due to any sexual difference.

Differences in sexual coloration develop with the onset of maturity, becoming more pronounced with increase in age. The large males at spawning time are bright blue, especially around the eyes and the adipose hump, which coloration is evidently associated with the development of the testes. A tinge of this bright blue can be observed even in the winter. The females, on the

other hand, are a darker and duller blue. In July the females are more brownish in color. Some are almost completely white, a condition not seen in the same population a few weeks earlier when they were in breeding condition. This change of coloration can be seen inshore towards the end of August on the Mussel Shoals and Five Fathom Bank near Cape May, New Jersey. At this time relatively few fish are found on these grounds since the majority have already left for deeper waters.

Table I

Table I. Frequency distribution of standard lengths in centimeters of male and female sea bass of four age classes taken off Cape May, New Jersey, during August and September, 1945. (Sub-sampled for statistical treatment.)

Standard length in centimeters	Age in years, and sex							
	IV		V		VI		VII	
	Male	Female	Male	Female	Male	Female	Male	Female
18.5	—	3	—	—	—	—	—	—
19.0	1	2	—	—	—	—	—	—
19.5	—	—	—	—	—	—	—	—
20.0	1	—	—	—	—	—	—	—
20.5	1	2	—	—	—	—	—	—
21.0	3	5	1	1	—	—	—	—
21.5	—	—	1	—	—	—	—	—
22.0	—	4	—	3	—	—	—	—
22.5	3	3	1	1	—	3	—	—
23.0	—	2	—	1	—	1	—	1
23.5	1	3	1	5	—	1	—	—
24.0	1	—	—	6	—	—	—	—
24.5	2	3	1	4	2	1	—	2
25.0	—	1	2	3	2	3	—	1
25.5	—	—	3	5	—	5	—	—
26.0	—	—	2	4	—	3	—	1
26.5	1	—	3	2	2	5	—	2
27.0	—	—	1	5	—	2	—	1
27.5	—	—	1	1	—	—	—	—
28.0	—	—	—	1	3	—	—	1
28.5	—	—	3	—	1	—	—	3
29.0	—	—	—	—	2	—	—	—
29.5	—	—	—	—	—	—	—	—
30.0	—	—	—	—	—	—	—	—
30.5	—	—	—	—	—	—	—	—
31.0	—	—	—	—	—	—	1	—
31.5	—	—	—	—	—	—	3	—
32.0	—	—	—	—	—	—	2	—
32.5 }	—	—	—	—	—	—	—	—
33.0 }	—	—	—	—	—	—	—	—
Mean	22.4	21.8	25.6	25.0	26.9	25.2	31.6	26.4

A significant difference has been observed in the maximum ages attained by each sex. Although Figure 2 indicates a typical spawning population wherein the maximum age of females is 8 years and that of the males is 12 years, several extremely large males ("jumboes") were caught

and determined to be considerably older. These, for the most part, are caught one or two at a time, ranging in deeper water than the vast preponderance of sea bass. These fish, considerably over 45 cm. standard length and weighing on the average over 5 pounds, were invariably males. Observations at sea were corroborated by examination of the commercial winter catches landed at New York City for the years during which this investigation was pursued. Examination of the scales of these males revealed at least 20 winter zones. It was difficult to determine exactly the ages of these fish since the zones are so close together.

Regressive ovarian tissue has been found in the males, associated with the region immediately anterior to the genital duct. As can be seen from Figure 4A, eggs are dispersed through the testicular region. Eggs were found through the testis in a male 15 years of age, and, although this male provided the best example of regressive ovarian tissue, the same condition was found in four younger males sampled. However, in a male of 6 years, a longitudinal section through the gonad did not reveal any ovarian tissue.

Within the walls of the ovary of the younger females epithelium can be found. In the older females (Fig. 4B) tubules can be seen in a stage of formation in this tissue. The tubular tissue appears identical with the developing, but as yet non-functioning, testicular elements of the young males. Figure 4B shows the male elements found in the ovary of a functional female in comparison with the female elements found in the testis of a functional male (Fig. 4A).

The unusual sex ratios in the year classes of the sea bass suggest protogynous hermaphroditism. This is supported by direct histological evidence. Ovarian tissue is shown to be regressive in the functional male, and testicular tissue is yet immature in the gonads of the functional females. It has also been observed by gonad study that the development of the new sexual tissue is correlated closely with the ages at which the sex of the fish would be expected to change according to scale and length-frequency data.

Figures 4C and 4D demonstrate tissue found in the male and female gonads in the posterior quarter of the organs. This tissue possesses a different staining reaction. It is believed at this writing that it is chromophilic tissue of the medullary adrenal. If so, this would be an unusual locus for such tissue, which usually occurs in association with the cardinal veins.

In Figure 2, which indicates the composition of a typical population by age and sex, it is noted that the two- and three-year-old fish of both sexes are present in relatively small numbers and the one-year-olds are entirely absent. It is known, however, that one-, two-, and three-year-old sea bass are found in greater quantity than would be indicated by any of the samplings of the sea-bass pots. Non-commercial fish gear, more successful in catching these smaller fish, fully establishes their presence, and the comparatively small representation of these youngest fish in the commercial catches does not indicate a relative scarcity on these grounds.

The histology of the sea bass gonads seems quite similar to that of close relatives. Van Oordt (1933) showed a condition in several Javanese serranids which appears similar to that of our sea bass. In the ovotestis, eggs

are interspersed among the seminiferous tubules in a manner quite similar to that shown in the photomicrographs of the functional male sea bass (Fig. 4A). Van Oordt, however, did not conclusively demonstrate normal hermaphroditism or sex change in either direction, since he lacked suitable material, his histological data not being substantiated by field data.

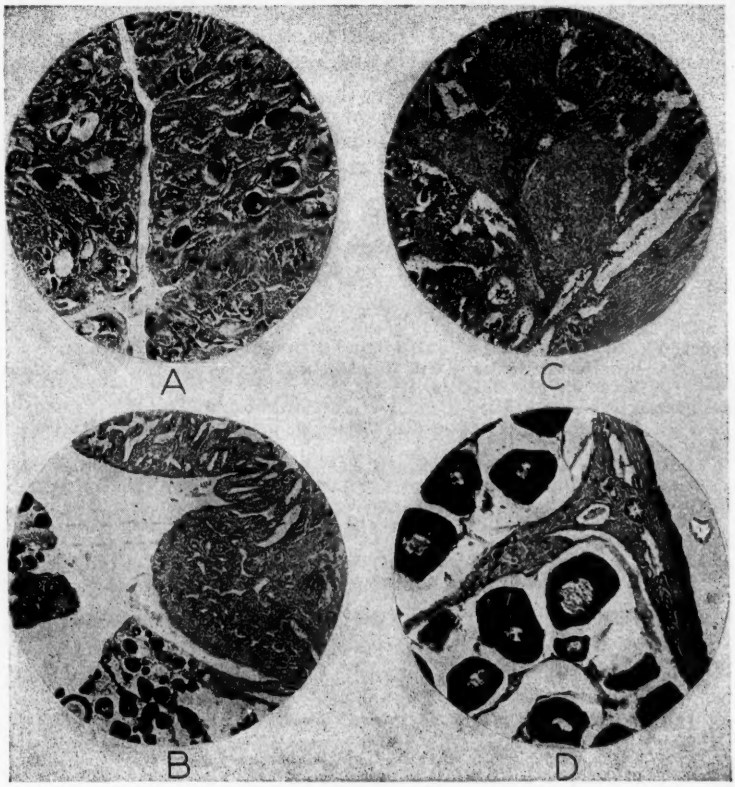

Fig. 4. Photomicrographs. A. Gonadal section × 63.1 of functional male showing regression of the ovarian tissue. B. Gonadal section × 53.4 of functional female showing developing testicular tissue. C. Gonadal section × 126.3 of functional male showing probable medullary adrenal tissue. D. Gonadal section × 145.7 of functional female showing probable medullary adrenal tissue.

SUMMARY

1. The sexes of *Centropristes striatus* are functionally distinct.
2. Secondary sex characters include the following:
   a. In males over 25 cm. an adipose hump is developed concurrent with the onset of reproductive activity. The appearance and shape

of the head are different in the two sexes. There are also minor differences in body shape and fin structures.

b. The male is more vividly colored, especially at spawning time.

3. Average and maximum sizes of males are invariably larger than females in all samples.

4. Growth rates diverge significantly after the first four years of life.

5. There are sharp differences in relative numerical proportions of the sexes in the various age groups. Females predominate in the younger groups, gradually diminishing until the tenth year, after which they disappear. Males live on for at least 10 more years.

6. These facts suggest a condition of protogynous hermaphroditism, such change occurring chiefly after the fifth year.

7. Regressive ovarian tissue is found in males in association with the sperm duct.

8. Testicular tissue arises from the epithelium lining the oviduct.

9. Medullary adrenal tissue is believed found in both sexes embedded within the gonad.

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The Family Name of the Characid Fishes

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THE characid fishes of tropical America and Africa are called by some authors Characidae and by some Characinidae, and the difference of opinion has endured for nearly a century. Eigenmann, the principal authority on the family, used Characidae but the reasons why he and the present writer have insisted on this form have plainly not been understood by some ichthyologists, and must be thoroughly explained if we are finally to have uniformity in the name of this important family.

The International Rules of Zoological Nomenclature (Article 4) state: "The name of a family is formed by adding the ending *idae*, the name of a subfamily by adding *inae*, to the stem of the name of its type genus." In this case the name of the recognized type genus of the family is *Charax* and all we should need to do is to determine what the stem of this word may be. However, Gill (1895*b*) confused the issue, and in order that the whole question be settled permanently it seems necessary to go into the etymology and complicated history of the generic names *Charax* and *Characinus*.

History of *Charax* and *Characinus*

Neglecting the earlier history of *Charax*, this name was first applied to a characid fish by Gronow in the first volume of his *Museum Ichthyologicum* (1754: 19). He proposed it and described it as a new genus for two new species from Surinam in his private museum. Gronow's descriptions and figures are excellent for those times and there is no difficulty in identifying the two species as *Charax gibbosus* (Linnaeus) and *Astyanax bimaculatus* (Linnaeus) of modern ichthyologists. The genus is again listed, without description, in the second volume of Gronow's *Museum* (1756: 13). This completes the so-called pre-Linnaean history of the name.

In the 10th edition of the *Systema Naturae* (1758: 311) Linnaeus accepts Gronow's two species without having seen them and gives them binomial names according to his new system. Linnaeus did not recognize the genus *Charax* and calls these species *Salmo gibbosus* and *S. bimaculatus*, but he did institute subdivisions of *Salmo*, as follows: "Truttae" (p. 308) for salmonids; "Osmeri" (p. 310) for smelts; "Coregoni" (p. 310) for whitefishes; and "Characini" (p. 311) for characids. In the last division he placed Gronow's two species of *Charax*, in addition to Gronow's *Anostomus* (1756: 13) and three other species.

These subdivisional names of Linnaeus have caused most of the trouble over *Charax* and *Characinus*. He gave them in the plural form only, but many subsequent authors have accepted them, in the implied singular form (*Trutta, Osmerus, Coregonus, Characinus*), as new genera dating from Linnaeus (1758). But to anticipate, we should note that the International Commission on Zoological Nomenclature, in Opinion 124 (1936), definitely stated: "The various Subdivisions of genera published by Linnaeus in 1758 are not to be accepted as of this date (1758) as of subgeneric value under the International Rules."

In naming his subdivision "Characini," Linnaeus was doing one of two things. Either he was using what he considered to be the proper plural form of *Charax,* or, not liking that name, he had decided to use a distinct but similar generic name, *Characinus.* The fact that Lacépède (1803: 269) and subsequent authors who were familiar with Gronow's works used *Characinus* for a generic name leads one naturally to the assumption that the second alternative is correct. This question is discussed below under "Etymology."

In the 12th edition of the *Systema* (1766: 513) Linnaeus continues use of the subdivisions, including "Characini," and so did Gmelin (1789). It is a notation upon the carelessness with which certain Opinions have been drawn up by the International Commission that these same subdivisions, as of 1766 and 1789, were not mentioned in Opinion 124 and might be held not to be affected by that Opinion. By analogy, however, we may presume that the Commission would exclude them from consideration.

It should also be noted that the Commission, in Opinion 124, left a loophole whereby their decision might be appealed if, in any special cases, it should cause more confusion than uniformity. With *Characinus,* supression of this name as of Linnaeus causes little or no confusion since modern writers have uniformly used *Charax* (see most of Eigenmann's papers subsequent to 1900, especially 1912; Schultz, 1944; etc.). Even the older writers who have monographed the characids (Müller and Troschel, 1845; Kner, 1859; Günther, 1864) failed to use *Characinus.* Cuvier (1817: 164; 1829: 308) did employ *Characinus* as a sort of group-name, but the fact that he placed no species under it and referred Gronow's and Linnaeus's species all to other genera, proves that he had abandoned *Characinus* as a strictly generic designation.

Subsequent to 1758, the first use of a generic name for these fishes was again by Gronow, in the first fascicle of his *Zoophylacium* (1763: 123), where he again used his generic name *Charax* for the two old species and three more new ones. But this work, like that of 1754, is "polynomial" so far as species go, and the International Commission, in Opinion 89, has eliminated it from consideration in zoological nomenclature.

Scopoli (1777: 455), a "binomial" author, accepted *Charax* and the name must date from his work. It should be noted that *Charax* is also available as of the index prepared by Meuschen in the third volume of Gronow's *Zoophylacium* (1781), a volume not included by the International Commission in the interdict against Gronow in Opinion 89.[1]

Lacépède (1803: 269) appears to have been the first to utilize the name *Characinus* in a way that allows acceptance under the International Rules.

[1] Opinion 89 was written and voted upon in the most careless manner. None of the Commissioners (even Jordan, who brought up the case) seems to have been really familiar at first hand with either the two volumes of Gronow's *Museum Ichthyologicum* or the three separate volumes of Gronow's *Zoophylacium.* The restriction to "Gronow 1763" in the Summary and the failure unequivocally to include the parts published at other dates appear to limit interdiction to first volume (fascicle) of the *Zoophylacium* and leave the nomenclatural status of the second and third ones either doubtful or unaffected. No Commissioner seems to have considered the non-fish names in Gronow. No Commissioner discovered that the third volume of the *Zoophylacium* had the Meuschen index, in which perfectly good binomial names are assigned to most of Gronow's new polynomial species. Whitley (1929) has attempted to straighten out the fish names given by Meuschen, but even Whitley's concordance does not agree wholly with a careful one I have made, and he and others are apparently in error in supposing that there was a new edition of the *Zoophylacium* published in 1781. Because of all this confusion I have given full bibliographic citations of all parts of both these Gronovian works in the "Literature Cited."

He places 16 species in the genus, including *gibbosus* and *bimaculatus*. But there can be no doubt, on etymological grounds, that *Charax* and *Characinus* are different words, and it is necessary to treat them as different zoological names, in spite of the fact that they have been used interchangeably. The question of possibly different genotypes thus arises, and should be settled here although the question is somewhat aside from the main one.

The Genotypes of *Charax* and *Characinus*

The writers who are concerned with genotype selection for *Charax* and *Characinus* are Swainson (1838; 1839), Gill (1895b), Eigenmann (1910: 444; 1912: 400), and Jordan and Evermann (1917). We may first take the genus *Charax* (Gronow) Scopoli, 1777.

Although I have been unable to consult Scopoli's work, all the many references to it lead me to believe that the species he included under *Charax* were exactly the same as those of Gronow (1763), since Scopoli appears merely to have copied Gronow's account of the genus. These five species, as given in the *Zoophylacium*, and with apparent synonymies added, are as follows:

No. 377. Charax maxillis aequalibus, etc., p. 123. America.
? (*Salmo*) *notatus* Linnaeus, 1766: 513. Surinam.
Charax notatus Meuschen, Index, in Gronow, 1781.
? *Charax lavaretus* Meuschen, Index, in Gronow, 1781.

No. 378. Charax maxilla superiore longiore obtusa, etc., p. 123. America.
(*Salmo*) *cyprinoides* Linnaeus, 1766: 514. Surinam.
Charax cynnoides (misprint for *cyprinoides*) Meuschen, Index, in Gronow, 1781.

No. 379. Charax maxilla superiore longiore, etc., p. 123. South America.
? (*Salmo*) *immaculatus* Linnaeus, 1766, p. 513. America.
Charax immaculatus Meuschen, Index, in Gronow, 1781.

No. 380. Charax . . . . . dorso prominulo gibboso, etc., p. 124. Surinam. (Description in Gronow, 1754: 19, tab. 1, fig. 4; Surinam.)
(*Salmo*) *gibbosus* Linnaeus, 1758: 311. Surinam.
(*Salmo*) *gibbosus* Linnaeus, 1766: 513. Surinam.
Charax gibbosus Meuschen, Index, in Gronow, 1781.

No. 381. Charax capite cathetoplateo, etc., p. 124. Surinam. (Description in Gronow, 1754: 19, tab. 1, fig. 5; Surinam.)
(*Salmo*) *bimaculatus* Linnaeus, 1758: 311. Surinam.
(*Salmo*) *bimaculatus* Linnaeus, 1766: 513. South America.
Charax bimaculatus Meuschen, Index, in Gronow, 1781.

The type of *Charax* must be one of these five species. The identity of Nos. 380 (*Charax gibbosus*) and 381 (*Astyanax bimaculatus*) is unquestioned, and that of 378 (*cyprinoides*) is fairly well established as a species of the genus *Curimata* Walbaum. Nos. 377 (*notatus*) and 379 (*immaculatus*) have never been placed, as Gill (1895b) remarks. Description of the mouth and teeth of *immaculatus* leads me to think it must be a *Prochilodus*, but the single black spot and other characters are confusing. *C. notatus* probably belongs to the *Tetragonopterus*-like group but is likewise unrecognizable. Neither needs further consideration.

Gill (1895b), who considers *Charax* and *Characinus* to be the same name, accepts the "principle of elimination," and ends with *gibbosus* as type, but the International Rules do not recognize this principle and demand that the

type species of a genus must be selected formally. Moreover, the Rules (Article 30 II g) state that "the meaning of the expression 'select the type' is to be rigidly construed." Under this ruling, the first author known to me who can in any way be said to have formally designated a type for *Charax* is Eigenmann (1910: 444). He selected *Salmo gibbosus* Linnaeus, and this designation is not open to subsequent change (Article 30 II g). We may now turn our attention to *Characinus*.

Characinus, as explained above, must date from Lacépède (1803) and a type must be selected from among its 16 original species. Swainson (1838; 1839) discussed the genus in a very unintelligent way, and used it in a different sense in his two volumes, but in no place did he plainly or even inadvertently designate a type for it. Nor did any other author apparently do so prior to Gill's 1895b paper.

Gill seemingly considered *Charax* and *Characinus* to be the same name, or two forms of the same name, but he used *Characinus* as of Linnaeus, 1758. This, of course, is now inadmissible, by act of the International Commission, but Gill also quotes the name as of Lacépède. He arrives at its type by the method of elimination, which we have seen is contrary to the Rules. He states: "Thus by successive eliminations the genus was finally restricted to *C. gibbosus*," and this is the only straightforward statement in his paper about the type of either *Characinus* or *Charax*. Clearly no statement in Gill's paper constitutes a genotype designation, rigidly construed. Nor did Eigenmann (1910) make such designation, because he does not even mention *Characinus*.

In 1912, however, Eigenmann (p. 400) formally lists *Characinus* of Lacépède under *Charax* of Scopoli. After the citations of both Swainson and Gill, Eigenmann lists *gibbosus* in parentheses in the way commonly used by ichthyologists to designate genotypes. But from the other such listings in the same synonymy, some of which contain two species in parentheses, strong doubt could be expressed that these are, *rigidly construed*, to be accepted as genotype selections. It would seems that Eigenmann was merely indicating what types he thought Swainson and Gill accepted. But surely neither of those men selected a type. Moreover, Eigenmann's statement, "Type, *Salmo gibbosus* Linnaeus," given later on the same page, can be held to apply only to *Charax*, the name he used formally, and not to whatever synonyms he quoted under that name. For example, it can not be held to designate a type for *Anacyrtus*, which is also quoted in the synonymy.

Jordan and Evermann (1917: 14) discuss the genotype of "Characinus" (="Characini") of Linnaeus 1758, and designate *gibbosus* as type, but we have shown that Linnaeus's plural name is inadmissible. However, on page 66 they definitely designate *Salmo gibbosus* Linnaeus as genotype of *Characinus* Lacépède, and this seems to be the first unambiguous type designation for that name.

Charax Scopoli and *Characinus* Lacépède, although different names, are therefore absolute synonyms and *Characinus* may be used only if and when *Charax* of Scopoli, Meuschen, Walbaum and possibly other 18th century writers is shown to be inadmissible.

Present Ichthyological Status of *Charax*

Charax, as understood by most recent authors, has been redefined to include only relatively few species by Schultz (1944: 295). The forms most closely allied to *gibbosus* have been most recently critically studied by Steindachner (1915: 586–590), but it is probable that some of the populations placed by him under *gibbosus* are recognizable.

Other Uses of the Names *Charax* and *Characinus*

Cuvier (1829: 308) and Swainson (1839: 288) both refer to the use of *Characinus* by Artedi for characid fishes. However, in Artedi's great posthumous work (1738) I can find no such use of that name. The only occurrence of either name in Artedi seems to be in the section on "Descriptiones Piscium" (p. 5), where *Charax* is listed as the name employed by Dubravius, Belon, and Gesner for the *Karass* or *Karausche* (*Carassius carassius*) of Europe. Artedi (and Walbaum, 1793: 5) also lists the χαραε of Aelian (*De animalium natura*) and of Oppian (*Halieutica*) under *Karass*. In fact, it is possible there is a philological relation between *Karausche, Charax,* and *Carassius,* but this takes us too far afield. Walbaum (1792: 659), in his greatly enlarged "second edition" of Artedi, does mention *Charax* of Gronow, but only to copy it.

Risso (1826: 353) proposes a new genus *Charax* for the sparid fish now known as *Puntazzo puntazzo* (Cetti) and *Charax puntazzo* appears in many lists of Mediterranean fishes. Of course, Risso's name is an unusable homonym, and has been replaced by *Puntazzo* Bleeker. According to Thompson (1947: 284) the original Greek use of Χαραε was for a sparid fish, but not *Puntazzo*.

Etymology and Stem of *Charax* and *Characinus*

Charax is the Latinized form of the classical Greek word Χαραε, Χαρακος, meaning a pointed stake or pale (such as is used in fortifying a rampart) or a vine-prop. Its use for a fish perhaps derives from the pointed row of teeth similar to a fence of pointed stakes.

The International Rules (Article 3) state: "The scientific names of animals must be words which are either Latin or Latinized, or considered and treated as such in case they are not of classic origin." *Charax* is the correctly Latinized form of the Greek term just mentioned, but it must be determined what the Latinized stem of the word would be in order to form the family name. From the Greek genitive, Χαρακος, it is plain that the Greek stem is Χαρακ–, which transliterated, is *Charac*–.[2] Presumably the Latinized word would be declined *Charax, Characis,* and never *Charax, Characinis*. Walbaum (1792: 53, 659) is the only author with whom I am familiar who uses the genitive case of *Charax*. He correctly uses *Characis*.

We have noted that Linnaeus used the plural form Characini as a group name. If he had thought that he were using the nominative plural of a word that was declined *Charax, Characinis* (that is of the third Latin declension)

[2] Professor R. D. Harriman, Chairman of the Classics Department at Stanford, has kindly gone over this case for me and assures me that *Charac-* is the only possible Latinized stem to be derived from Χαραε. Thanks are due to him for his help.

he would have written *Characines*. That he used Characini as the plural nominative demonstrates clearly that he was not using Gronow's name *Charax* at all, but rather a new name, *Characinus*, belonging to the second Latin declension and derived from *Charax* but wholly distinct from it. Linnaeus's reason for using a new name was probably the fact that old authors had used *Charax* for European species, and he wished to avoid confusion by giving a new group name to these tropical fresh-water fishes.

There is, therefore, no zoological, nomenclatural, or etymological reason for supposing that the stem of *Charax* is *Characin–*. The stem of *Charax* is *Charac–*, and adding *idae* to the stem produces the family name Characidae. Only if *Characinus* be accepted can the name be Characinidae.

Family Name of the Characid Fishes

The above discussion demonstrates that the name *Characinus* dates from Lacépède 1803 and is an absolute synonym of *Charax* (Gronow) Scopoli, 1777. These two generic names are the only ones that have ever been concerned with the formation of a general family name for the characid fishes, or, if the family be broken up into several, for that restricted family containing the genus *Charax*. As a synonym, *Characinus* can not be used to form a family name. Therefore, under the International Rules of Zoological Nomenclature (Article 4), the only admissible name for the family of characid fishes is Characidae.

The vernacular family term "characin" or "characins" was apparently first introduced by Cuvier (1817: 164), and has become firmly established in French and in English, chiefly through its wide use by Eigenmann, the chief authority on the group, and more recently by aquarists, to whom the characins are well known. Because of its establishment, it may be accepted, but a preferable term would be "characid," plural "characids."

Gill (1895a: 205–206) has given an excellent synonymic list of the family names applied to the characids. From this it is evident that the name Characidae was first used by Agassiz in 1844, but the first subsequent use was by Gill in 1893. The first two usages of the form Characinidae were by Richardson in 1856 and Günther in 1864.

Finally, it may be said that Gill (1895a) divided the Characidae into two families and Regan (1911) split them into six. Following Eigenmann, I prefer to keep them all in one large family, although the subdivisions represented by Regan's families are perhaps the most natural and sensible yet proposed. Much unpublished research of my own shows that the subfamily arrangement of Gregory and Conrad (1938) is artificial in many ways.

Summary

1. Two names, Characidae and Characinidae, have been widely used for the large family of characid fishes. In order to demonstrate which is correct, it has been necessary to trace the history and explain the etymology of the generic names *Charax* and *Characinus*.

2. *Charax* and *Characinus* have been confused by ichthyologists or considered to be the same name. They are different names, and Linnaeus, who

proposed *Characinus* in 1758 solely in the plural form (Characini), shows by the plural ending used that he did not consider *Characinus* to be the same name as *Charax*.

3. Under rulings of the International Commission on Zoological Nomenclature (Opinions 80 and 124), *Charax* Gronow, 1763, and *"Characinus"* (Characini) Linnaeus, 1758, are eliminated from consideration. *Charax* Scopoli, 1777, and *Characinus* Lacépède, 1803, are the earliest admissible usages.

4. The first admissible, "rigidly construed" selection of a genotype for *Charax* was by Eigenmann in 1910, and for *Characinus* that of Jordan and Evermann in 1917. The type of both names is *gibbosus* Linneaus, 1758. *Characinus* is, therefore, an absolute synonym of *Charax* and cannot be used to form a family name.

5. The stem of *Charax* is *Charac–*, and the zoological family name based on it must be Characidae.

6. Under the International Rules, the correct family name must be Characidae and not Characinidae. The earliest use of the name Characidae was by Agassiz in 1844.

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1756 "Musei / Ichthyologici / tomus secundus / sistens / Piscium / indigenorum & nonnullorum exoticorum, / quorum maxima pars / in / Museo / Laurentii Theodori / Gronovii, J.U.D. / adservatur, / nec non / quorumdam in aliis Museis observatorum / Descriptiones. / Accedunt / nonnullorum exoticorum

Piscium icones aeri incisae, / et / Amphibiorum Animalium / Historia Zoologica. / [Decoration.] / Lugduni Batavorum, / sumptibus Auctoris. / Prostat apud Theodorum Haak, / MDCCLVI." Title-page, 2 pages preface, 3 pages "Syllabus auctorum", 1 page table of contents, 88 text-pages, 3 plates numbered 5, 6, 7; pl. 7 facing p. 4, pl. 5 facing p. 24, pl. 6 facing p. 26. Folio, 36.5 x 25.5 cm.

1763 "Zoophylacii / Gronoviani / fasciculus primus / exhibens / Animalia / Quadrupeda, / Amphibia / atque / Pisces, / quae in / Museo suo adservat, rite examinavit, syste- / matice disposuit, descripsit, atquae / iconibus illustravit / Laur. Theod. Gronovius, J.U.D. / [Three lines of personal titles. / Decoration.] / Lugduni Batavorum, / sumptibus Auctoris. / MDCCLXIV." Title-page, dedication page, text-pages 1–136, 4 pages of explanation of plates, 17 folded plates, of which 13 are of fishes and 4 of insects and crustaceans. Folio, 38.5 x 24.5 cm. [In my personal copy, in which all three fascicles are bound together, the insect and crustacean plates are with the fish plates, and were plainly published with the first fascicle, because the explanation for them is present and is continuous with that for the fish plates.]

1764 "Zoophylacii / Gronoviani / fasciculus secundus / exhibens / enumerationem / Insectorum / quae in / Museo suo adservat, examini subjecit, / systematice disposuit atque / descripsit / Laur. Theod. Gronovius, J.U.D. / [Three lines of personal tities.] / Additis rarissimorum Insectorum iconismis. / [Decoration] / Lugduni Batavorum, / sumptibus Auctoris. / MDCCLXIV." Title-page, dedication page, text-pages 141–236. Folio, 38.5 x 24.5 cm. [In spite of the notation on the title-page, the insect and crustacean plates appeared in the first fascicle, not the second. See explanation above. There are no plates with this fascicle.]

1781a "Zoophylacii / Gronoviani / fasciculus tertius / exhibens / Vermes, / Mollusca, Testacea, / et Zoophyta, / quae in / Museo suo adservavit, examini subjecit, / systematice disposuit atque / descripsit / Laur. Theod. Gronovius, J.U.D. / [Three lines of personal titles.] / Additis rarissimorum objectorum iconismis. / [Decoration] / Lugduni Batavorum, / apud / Theodorum Haak et Socium / et / Samuelem et Johannem Luchtmans. / MDCCLXXXI." Title-page, dedication page, 4 pages of preface by Petrus Boddaert, general title-page for all three fascicles, text-pages 241–380, 19 unnumbered pages of indices [to all three fascicles] by Meuschen, 2 pages of explanation of plates, 3 folded plates of shells and corals numbered 18, 19, 20. Folio, 38.5 x 24.5 cm. [The preface by Boddaert explains the editorship of Meuschen subsequent to Gronow's death. The title page to the entire work was, as usual, issued with the last fascicle. That in some copies it may have been bound in at the proper place, at the front of fasc. 1, appears to explain the belief of some authors that there was a re-issue of the entire work in 1781. It is exceedingly doubtful that such a reprint was ever made. This general title-page is quoted in full in the following citation.]

1781b "Zoophylacium / Gronovianum, / exhibens / Animalia / Quadrupeda, Amphibia, / Pisces, Insecta, Vermes, / Mollusca, Testacea, /et Zoophyta, / quae in Museo suo adservavit, examini / subjecit, systematice disposuit / atquae descripsit / Laur. Theod. Gronovius, J.U.D., / Civitatis Lugduno Batavae Senator, Societatis Physico- / Medicae Regiae Londinensis, Basilaeensis, / atquae Hollandicae Socius. / Additis rarissimorum objectorum iconismis. / [Triple bar across page.] / Lugduni Batavorum, / apud / Theodorum Haak et Socium / et / Samuelem et Johannem Luchtmans. / MDCCLXXXI." [This is the title-page for the complete work of three fascicles and was issued as part of fasc. 3. See above under fasc. 3 for explanation.]

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Changes in the Cranial Nerves of the Paddlefish, *Polyodon spathula*, Accompanying Development of the Rostrum

By R. WELDON LARIMORE[1]

A CAREFUL anatomical study of larval *Polyodon spathula* (Walbaum), strange paddlefish of the Mississippi River Basin, revealed an unsuspected transposition in the cranial nerves accompanying development of the rostrum. Comparison between large paddlefish and larvae disclosed that during rostral growth the eyes, nasal pouches, and barbels alter their position relative to the brain. In following this unusual migration of sensory structures, four small paddlefish were used. These ranged between 17 and 26 mm. in length. They possessed only the rostral bud as an indication of the enormous "paddle" which characterizes the adult paddlefish. Two larger specimens, 212 and 750 mm. long, with the rostrum fully formed, were also used.

COLLECTIONS OF YOUNG

Because of the significance of *Polyodon* in the evolution of bony fishes, comparative anatomists have made extensive searches for its young. Since these searches disclosed few young and no larval paddlefish until rather recently, the specimens available for this investigation were of unusual interest. During the spring of 1904 and 1905, Stockard (1907) carried on a

[1] The post-larval paddlefish used in this study were collected by Dr. David H. Thompson and Mr. Paul G. Barnickol, both formerly with the Illinois Natural History Survey. The problem was suggested by Dr. George W. Bennett and supported by the Illinois Natural History Survey. Professor F. B. Adamstone, of the Zoology Department, University of Illinois, gave technical assistance and constructive criticism of the manuscript.

survey of the paddlefish in the lower Mississippi River and certain of its tributaries. Although examining a great many adult fish, he was unsuccessful in securing any very young specimens. A few small paddlefish have been collected. Danforth (1910) described a 74-mm. specimen collected near St. Louis. Barbour (1911) reported five young paddlefish 35, 37, 65, 80 and 85 mm. in length. Although he presented but a short comparative description of these fish, his paper did give a series of interesting sketches of the smallest forms known at that time. The first collection of larvae was made in May of 1932, when Thompson (1933) collected seven young paddlefish, 17 to 20 mm. long, from the Mississippi River near Grand Tower, Illinois.

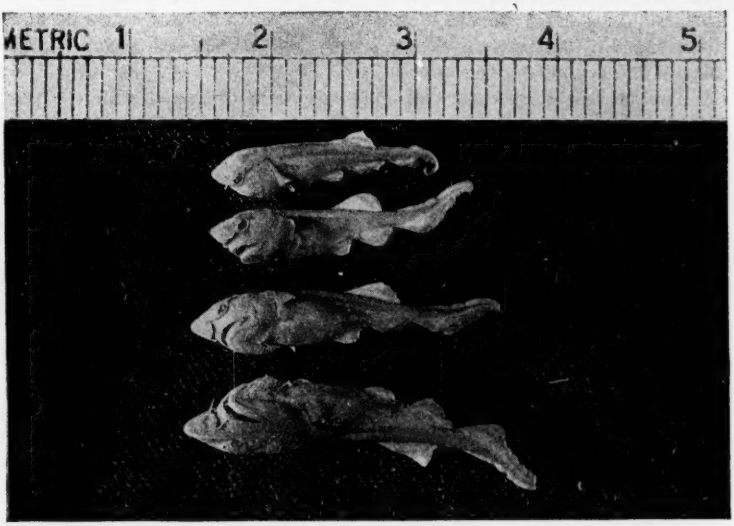

Fig. 1. Four post larval *Polyodon* from the Mississippi River. The smallest (17 mm.) and the largest (26 mm.) were sectioned for study. (Magnified × 2.3.)

In 1944, during test netting operations on the Mississippi River, an investigation carried on jointly by the Missouri Conservation Commission, the Illinois Department of Conservation, and the Illinois Natural History Survey, the four small paddlefish used in this study were taken in minnow seine hauls. These post-larvae were collected by Dr. D. H. Thompson and Mr. P. G. Barnickol near Cape Girardeau, Missouri, on May 29, 1944. They were taken with a $\frac{1}{6}$-inch mesh minnow seine in the main channel of the Mississippi River near an island sand bar. At this point the water was less than 3 feet deep and the sandy bottom was covered with a layer of muddy ooze. The river level was high, turbidity measured 1,500 ppm. on a U. S. Geological Survey scale, and water temperature was 77° F. The four specimens measured 17, 19.4, 25.5 and 26 mm. in length. No critical examination was made of these specimens until they were offered for study in the fall of 1946.

Description of Specimens

The photograph of the small paddlefish (Fig. 1) illustrates the appearance and proportions better than any lengthy description. Clearly the rostrum is undeveloped, the barbels are relatively large, the mouth is lined with teeth, and the fins are weakly formed. The distribution of sensory pits is apparent over the operculum and side of the head. Measurements indicate the only major changes of body proportions accompanying the growth of young *Polyodon* are those closely associated with the rostrum.

The four post-larvae were fixed in Bouin's solution and stored in 70 per cent alcohol until ready for embedding. The largest (26 mm.) and the smallest (17 mm.) specimens were embedded in paraffin and sectioned longitudinally at 10 microns. Both specimens were stained with Harris' haematoxylin and counter-stained in eosin.

Two additional specimens of *Polyodon* were compared with the post-larval paddlefish. One specimen was 212 mm. long, with the rostrum making up 70 mm. (or 33 per cent of the total length) and having the adult body form. No dissection was made of this fish, but the translucent cranium allowed detailed observation of the brain and relative position of sensory structures. The other specimen was 750 mm. long and its rostrum constituted less than one-third of the total length. Removal of the cranial roof exposed the brain and the larger nerves (Fig. 2). An attempt has been made to show the changes in position and development of sensory structures and related cranial nerves in the 17-, 26-, 212- and 750-mm. specimens.

Olfactory Structures

The olfactory lobes of the 17-mm. *Polyodon,* as shown by the microscopic sections (Fig. 3), are scarcely more than slight bulges on the anterio-dorsal surface of the two divisions of the fore-brain. The olfactory nerve (cranial nerve I) arises on the anterior surface of the olfactory lobe as a bundle of fibers running distinctly laterad from its origin. This large nerve continues back and laterally in close association with the margins of the olfactory lobe and fore-brain. Midway in its extent the nerve incompletely divides, the strands continuing together until they approach the nasal sacs where they break up into numerous branches (Fig. 3, B, E).

The nasal sacs in this 17-mm. specimen lie closely laterad to the fore-brain and extend caudad to open opposite the mid-brain (Fig. 3, E, F, G). Each sac has two external openings (Fig. 1), one immediately in front of the eye, the other slightly forward and above the first. The two openings are so arranged that water can circulate through the sac. Thus the olfactory nerve approaches the nasal sac at its anterior portion and spreads over the numerous finger-like folds which serve to increase the olfactory epithelium (Fig. 3, B).

Although the rostrum remains undeveloped in the 26-mm. post-larva, changes are present in the olfactory structures which indicate the modifications that will ultimately take place. An enlargement of the olfactory lobe makes it distinct from the fore-brain, although the small cavity of the lobe is still continuous with the cerebral ventricle. The position of the nasal sac,

now somewhat farther forward of the mid-brain than was described for the 17-mm. fish, remains caudad to the origin of the olfactory nerve, and thus the nerve still extends backward to its receptor.

Full development of the rostrum is attained in the 212-mm. specimen, the "paddle" constituting one-third the total length. The position of the nasal sacs laterad to the brain is now almost entirely anterior to the fore-brain, so that the olfactory nerve no longer extends backwards but runs laterally to the sacs. The growth of the enormous rostrum has not shown the limit of its influence on this specimen, for the 750-mm. paddlefish revealed even more alteration of the olfactory nerve and position of the nasal sac. In the latter fish the olfactory nerve lies distinctly in front of the fore-brain at a 45° angle with the longitudinal axis of the body (Fig. 2). In relation to the brain, the nasal sac is now far anterior to the position it occupied in the larval specimens.

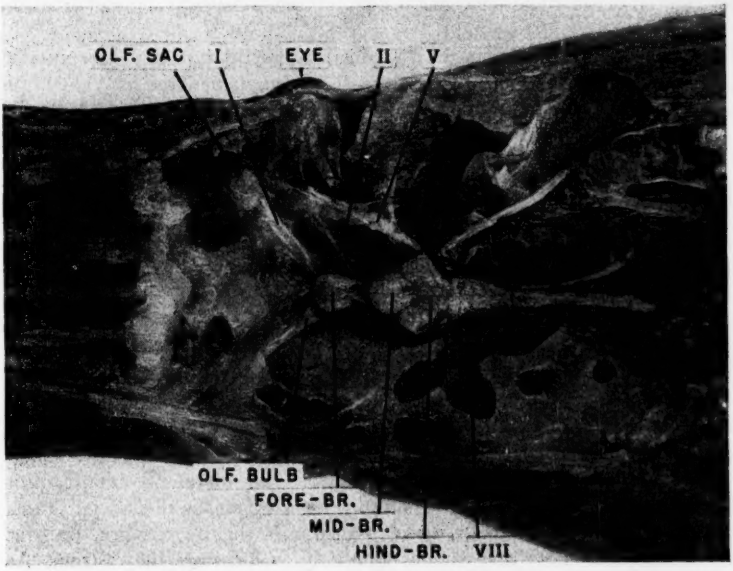

Fig. 2. Dorsal aspect of dissected brain of 750-mm. paddlefish. (Magnified × 1.1.)

Optic Structures

Eyes are small and weak in *Polyodon*, presumably resulting from the limited value of sight in securing the micro-organisms on which this species feeds. As might be supposed, these weak visual structures follow transitions similar to those discussed for the olfactory organs; in fact, the relative positions of the nasal sacs and the eyes remain constant to one another, the change in location coming about in respect to the brain.

In the post-larval stage the eyes are comparatively well developed, to the extent, at least, that the optic structures are fully formed. Figure 3, G, shows the eyes of the 17-mm. paddlefish. At this stage of development, the pigment layer of the eye is quite apparent, as are the other parts of the retina. The nerve (cranial nerve II) is shown as it passes through the optic capsule and enters the back of the eye. As shown in Figure 3, F, G, the eye in this specimen lies directly laterad to the basal division between the mid- and hind-brain. The optic nerve forms a chiasma at the base of the posterior portion of the fore-brain, extends laterally through the cartilaginous cranium, and goes slightly caudad to enter the eye. Critical examination of the eyes in the 17- and 26-mm. paddlefish revealed little difference in the two fish.

In contrast to the condition in the larval stages, where the eye lies opposite the posterior portion of the mid-brain, the 212-mm. paddlefish has the eye farther forward; the back of the orbit is even with the posterior margin of the fore-brain. The optic nerve now protracts distinctly laterad from its origin.

The center of the eye in the 750-mm. specimen is even with the anterior edge of the fore-brain (Fig. 2). In the dissection of the large individual, the relative smallness of the brain in comparison to the eye is quite apparent. Obvious too, is the forward path of the optic nerve as it passes to the eye.

Barbels and Innervation of the Rostrum

The hind-brain of the paddlefish is divided into two distinct parts, the cerebellum joining the mid-brain and the posterior medulla. Where it joins the cerebellum, the medulla is the widest region of the central nervous system but narrows posteriorly to form a cylindrical tube which extends caudad as the dorsal nerve cord. The medulla is covered by a thin choroid roof and has a large ventricle surrounded laterally by the unique rectiform tract. The importance of the medulla should be emphasized because it gives rise to cranial nerves V-X.

In this consideration of the sensory endings in the rostrum, full importance will be given cranial nerve V, which innervates the entire snout. This nerve, the trigeminalis, arises well up on the side of the anterior part of the medulla. Immediately the stalk of the trigeminalis divides into three branches; the first and most dorsal branch goes slightly outward, up over the oculo-motor nerve and extends anteriorly to innervate the rostrum. As this branch runs forward parallel with the rostral splints, it sends off numerous fibers to sensory pits in the epithelium (Fig. 3, C, G). These ampullae are scattered along the side of the rostrum from a region near the nasal pouches to the site of the barbels, and each receives fibers from the branch of the trigeminalis.

The paired barbels also obtain their nerve supply from the first branch of the trigeminalis. As shown in the picture of the post-larval paddlefish, the barbels are proportionately many times larger in the very young specimens than in adults, where they are so diminutive that they even escaped consideration for many years in the descriptions of this species. The exact

function of the barbels has been questioned by many who have examined these structures in the adult *Polyodon*. Wagner (1904) decided it was "doubtful whether they are functional." However, on investigation of the

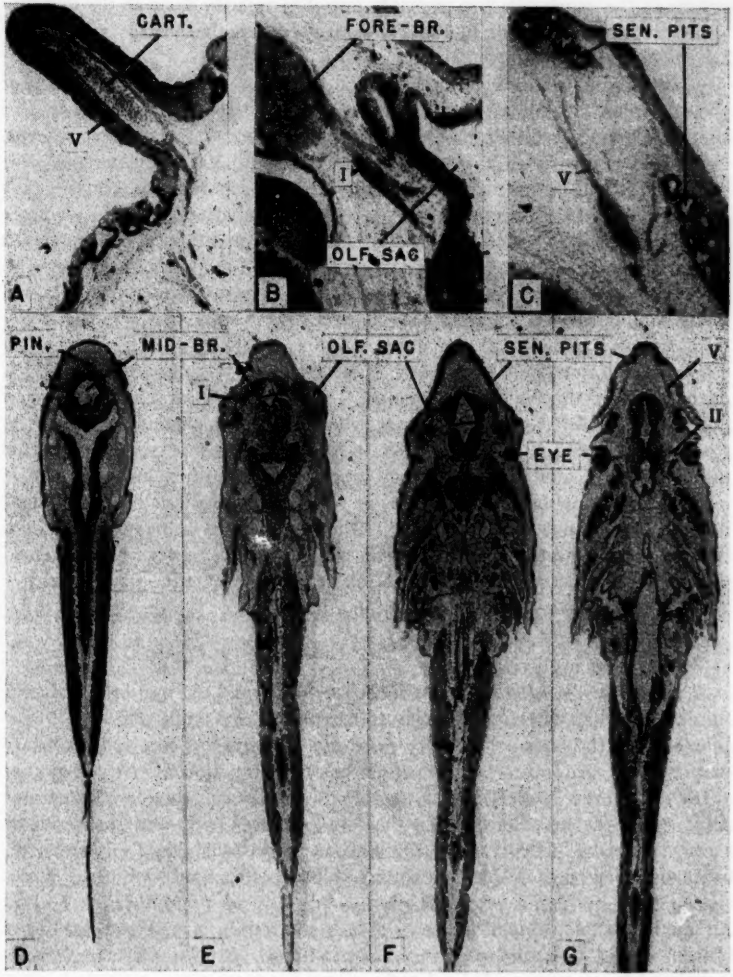

Fig. 3. Sections of 17-mm. *Polyodon*: A, longitudinal section through barbel; B, olfactory nerve (I) and nasal sac; C, innervation of sensory pits on rostrum; D, entire section through upper portion of brain and the end organ of pineal; E, section from which B was taken; F, section through middle portion of brain; G, section from which C was taken, showing optic nerves (II) and posterior opening of nasal sacs. (A, B, C magnified × 71.4; D, E, F, G magnified × 10.)

comparatively large barbels of the post-larvae, one finds that these structures receive prominent nerve fibers and that between the core of cartilage and the surrounding epithelium there is a layer of nervous tissue (Fig. 3, A). From this evidence, one may conclude that the barbels are functional as sense organs in the young fish, but probably lose this capacity early in the development of the rostrum, for in the 212-mm. specimen the barbels are already relatively minute.

Continuing anteriorly from the region of the barbels, the first branch of the trigeminalis sends a profuse nerve supply into the small rostral bud of the larval paddlefish. From the 17- to the 26-mm. stage of development, even though the snout has prolonged but slightly, it is obvious that this nerve stock will be carried forward into the forming rostrum. In the 212-mm. specimen the well-formed rostrum is still translucent and the abundance of nerve endings is quite noticeable. Although no attempt was made to follow the nerves into the leathery snout of the 750-mm. fish, there seems to be no reason to believe that the nerve roots degenerated after being retained in the well-developed snout of the 212-mm. specimen.

Conclusive anatomical evidence for the function of the rostrum in *Polyodon* will not likely be derived from a study of young specimens which do not possess the paddle-like snouts. Thompson (1934) said the rostrum "may be considered a benign tumor which has been partially fixed in its characteristics and is in some degree useful as a bearer of sense organs for the detection of food." Collections of large specimens which thrived in their natural habitat without their rostra, as well as observations on the general behavior of the fish, led Stockard (1907) to regard it as more of a tactile organ to compensate for the reduced sense of sight. In either instance, whether as a structure for food detection or a guiding tactile organ (which I am inclined to believe), it is sensory in function.

Other Changes in the Cranial Structures

Deep in the constriction between the fore-brain and the mid-brain arises a thin diverticulum extending dorsally to the roof of the skull. This small protuberance of the brain, the epiphysis or pineal body, has received much attention from anatomists because of its one-time function as a third eye in ancestral forms. In *Polyodon* it remains a relatively prominent structure. As it leaves the junction between the fore- and mid-brain and runs upward through its canal in the cranium, the stalk increases considerably in diameter, is accompanied on each side by two large blood vessels, and terminates in the cranial roof by flaring out into the so-called "end organ" (Fig. 3, D). Although this "end organ" presents a very interesting structure, there is no indication that it is used as a receptor of stimuli. But, as Garman (1898) stated, "if its present condition is taken into account one must conclude that the structure is, or has recently been, an important sense organ to the sturgeons" (with which he included *Polyodon*).

The pineal body projects abruptly dorsad from its origin in both the 17- and 26-mm. specimens. This organ does not, however, escape the effect of the rostral growth; for as the cartilage of the brain case is drawn forward by

the extension of the snout, the pineal structure is carried with it. Thus, in the larger specimens, the canal runs distinctly forward from its origin, so that the "end organ" lies well anterior to the fore-brain. The situation of the pineal body in the adult paddlefish is clearly shown by Garman (1898) in the first figure of his work, which is a side view of the brain with the cartilage removed.

No attempt has been made here to describe each of the cranial nerves, but one other cranial nerve, the auditory, warrants some mention. Even in the two small specimens the auditory nerve (cranial nerve VIII) is well developed. Immediately behind the origin of the facial nerve on the medulla the auditory nerve arises and sends two branches, one forward and one backward, to the auditory regions of the cranium. The chambers of the inner ear and their respective structures are apparent in the 17-mm. specimen but not nearly so distinct as in the somewhat larger 26-mm. fish. The crista receiving branches of the auditory nerve and the otoliths are well formed even in the smaller specimen. Hence the inner ear of *Polyodon* is probably functional even in the earlier stages of the larval paddlefish.

Because of the relative difference in size of the brain and brain case (a condition to be discussed below), modifications of the inner ear in this series of specimens are difficult to point out. A critical comparative examination of the sections of the 17-mm. larva and the 750-mm. specimen reveals that the entire auditory region of the cranium is considerably farther forward in the adult fish. The auditory passage is entirely caudad to the cerebellum in the larval stage, whereas in the adult part of the canal extends forward to lie opposite the mid-brain.

As has been mentioned, the proportional size of brain and brain case changes remarkably during the growth of the fish. Wilder (1875) noticed that the brain of an adult *Polyodon* only partially fills the cranial cavity and questioned whether at some stage in development the volume of the brain nearly equals the capacity of the cavity. On examination of the slides of the 17- and 26-mm. paddlefish, it is apparent that the differential development begins in the post-larval stage, for in the smaller specimen the brain fills the cranial cavity while in the 26-mm. fish there is considerable space around the brain.

Comparison of the two larger paddlefish in this series with the small individuals further emphasizes this difference. By contrasting the dissection of the 750-mm. fish shown in Figure 2 (observe left side of cranium) and the sections of the larval stage in Figure 3, D-G, one may readily see the difference in space around the brain. During growth of the cartilaginous cranium, the brain has failed to fill the entire brain case.

From the cranial structure in the adult paddlefish one might conclude that, rather than having a migration of the sensory structures forward past the brain, there has been a withdrawal of the brain to the posterior portion of the spacious brain cavity. Such a condition would give the same effects of relative positions. But on closer examination of the differential development of the brain through this series of individuals, this idea becomes less credulous. It seems easier to believe that the rostrum is an over-growth of certain

cranial cartilage and during the development of this enormous structure the other regions of the skull are drawn forward, carrying with them the sensory structures and leaving a greater space around the brain than first existed.

Summary

1. An extensive transition of the cranial nerves is disclosed when microscopic sections of 17- and 26-mm. post-larvae are compared with translucent and dissected specimens of 212- and 750-mm. *Polyodon*.

2. The position of the nasal sacs relative to the brain in the larval paddlefish results in a lateral and backward extension of the olfactory nerve. In the larger paddlefish this nerve extends distinctly forward because of a change in the relative position of the nasal sacs.

3. The optic nerve in the larval fish projects laterally to supply the eye; in the larger fish its direction becomes distinctly anterolateral.

4. The large barbels and small rostral bud of the larva are well innervated by the first branch of the trigeminalis. In the 750-mm. *Polyodon* the large "paddle" appears to be well supplied with nerves but the inconspicuous barbels have obviously lost their sensory functions.

5. Also experiencing a forward transposition during growth of the cranium, the pineal body in the larva extends almost vertically above its origin; in larger specimens it slants anterodorsad through the roof of the cranium.

6. An increase in the proportional size of the cranial case to the brain follows development of the skull, the brain filling its cavity in the larva but not in the larger fish.

7. The proportionately small size of the adult brain as compared to the cranial case may account for the change in relative position of the sensory structures; however, it appears more likely that the brain does not retreat to the back of the spacious mature skull cavity, but rather the cartilaginous cranium grows forward with the development of the rostrum.

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Variations in the Blood Cell Volume of Individual Fish

By R. T. Young

THE purpose of the research described in the following account was to determine whether large variations in the blood of different fishes have their counterpart in that of the same individual at different times, using for this purpose the cell volume per cent as determined in the Van Allen (1925) hematocrit tube.

Evidence of high variability in fish blood has been presented by many workers (Baudin, 1936; Kokubo, 1927; Schlicher, 1927; Zunz, 1933; Black, 1940; etc.), and I have found variations in the red-cell count of individual fish ranging from less than one to more than four million cells per cubic millimeter.

The hematocrit method affords a convenient and reliable way of determining variations in cell volume regardless of the extent to which this volume is determined by size or number of cells present.

I am indebted to Dr. H. U. Sverdrup, formerly Director of the Scripps Institution of Oceanography, for the privileges of the Institution during this research, and to other members of the staff for many courtesies shown me.

Methods

The species used in my experiments was the opaleye (*Girella nigricans*), a common tide-pool fish on the California coast. The fish were kept in separate wire cages in aquaria amply supplied with running water except on one occasion when an inadequate supply resulted in the death of three fish.

After anesthetizing the fish with 1 per cent urethane solution, blood was obtained by pricking the caudal artery at a point approximately above the posterior margin of the anal fin. In this way a free flow of blood was usually obtained, but occasionally the operation was unsuccessful. Most of the opaleyes, which are hardy fish, sustained this operation very well. One specimen was bled frequently for 26 months, with a range in weight between 265 and 300 grams, being finally killed accidentally. Another lived from November 9, 1944, to May 20, 1946, when it too was killed accidentally, gaining in weight meanwhile from 27 to 74 grams. A period of at least 10 days, and usually 2 weeks or more, intervened between successive bleedings.

Considerable difficulty was experienced with clotting, even though the blood was drawn quickly into chilled tubes greased with paraffin oil, and the anti-coagulant (5 per cent sodium citrate in Ringer's solution) was introduced as quickly as possible: many samples had to be rejected on this account. The blood samples were centrifuged for two periods of 10 minutes each at approximately 2100 r.p.m. and the volume was read at the end of each run.

Results

Twenty-one fish were used in my experiments, the results of which are shown in the accompanying table and graphs. The table records the number

and duration in days of the experiments, the maximum, minimum, and mean volume per cent of cells (including both reds and whites[1]), the per cent of variation based on the mean value, and the sex of the individual concerned; while the graphs show the cell volume per cent, the weight of the fish, and the temperature of the aquaria, in five experiments that are representative of the entire series. The experiment numbers in the table and the figure numbers assigned to the graphs correspond to those of the fish for which data are presented therein. These data show clearly that variations, ranging from 15 per cent in No. 3 to 156 per cent in No. 17, may occur in the blood of the same fish over periods of several months.

TABLE I

VARIATIONS IN BLOOD CELL VOLUME AMONG THE 21 FISH CONSIDERED IN THIS STUDY

Expt. No.	Duration of expt. in days	Blood cell volume			Percent of variation based on the mean	Sex
		Max.	Min.	Mean		
1	192	26	15	20.5	54	F
2	235	33	19*	26	54	M
3	258	26	18	22	36	M
4	258	32	16	24	67	M
5	181	28	16	22	55	M
6	121	22	15	18.5	38	F
7	126	35	23	29	41	M
8	154	28	24	26	15	M
9	192	27	15	21	57	F
10	153	31	22	26.5	34	F
11	115	26	22	24	17	F
12	244	32	16	24	67	M
13	216	28	18	23	43	M
14	217	29	18	23.5	47	F
15	234	28	22	25	24	F
16	94	28	15	21.5	60	F
17	326	24	3	13.5	156	M
18	254	25	13	19	63	—
19	194	30	22	26	31	F
20	217	29	19	24	42	F
21	126	29	21	25	32	—

* During a period of tail rot the percentage dropped to 11.

Number 17 had a very interesting history. This fish underwent a prolonged depression from October 11, 1945, to December 6, 1945, during which time it ate sparingly or not at all, although it lost only a little weight (from 29 to 26 grams), while its cell volume was only 5.5 per cent or less.[2] Not only was cell volume low but the color of the blood was pale, indicating a very low hemoglobin value. Beginning on December 6, 1945, and continuing to March 31, 1946, the fish gradually recovered, eating well and gaining weight from 26 grams on the former date to 34.5 grams on the latter, while the cell volume rose from 5.5 per cent to 20 per cent during that time. I have occasionally observed anemic fish in aquaria, and Krogh and Leitch

[1] A distinction between red and white cells was usually not possible, the latter forming a very thin and indefinite layer on the surface of the cell column.

[2] At this level in the tube readings are very difficult because of the rubber band which seals the tube.

(1919: 291) mention two similar cases in marine fishes.

While the purpose of this research was to determine the amount of variability in the blood of individual fish rather than the cause(s), I have nevertheless examined my results in an attempt to correlate them with any possible factors, such as food and temperature. The results of this analysis are presented herewith.

In the earlier part of the work the fish were fed irregularly, but beginning on January 17, 1946, they were fed at one- to three-day intervals, and a record was kept of their response and weight. A comparison of cell volume and feeding response shows no relation between them except where marked anemia occurred. There undoubtedly was some underlying factor responsible for both anemia and loss of appetite. Absence of correlation between cell volume and appetite is well shown by No. 4, which had a distinct drop in cell volume between January 24, 1946, and February 8, 1946, although it was feeding well and its weight remained constant during that time.

Neither is there any correlation between weight and cell volume. While the two functions usually ran more or less parallel, there were several cases in which the weight increased or remained stationary while the cell volume was falling (for example: No. 2, January 10 to February 20, and April 17 to May 15, 1946; and No. 3, January 10 to January 23, and June 12 to June 25, 1946), and some in which the reverse occurred.

A comparison of temperature, weight and cell volume shows no correlation between the former (seasonal) and the two latter functions, a result which agrees with the conclusion of Kiermier (1939) regarding blood sugar.

My observations throw no light on the rhythms described by Baudin (1936) in the blood of *Perca fluviatilis* and certain other fishes. Baudin's method involved the use of many fish, which introduces the factor of individual variation, while I used the same specimen in each experiment. His observations also covered a period of 11 days only, while mine continued for several months.

At least some of the variations that I have described are considerably larger than those of Baudin. His data are inadequate for determining their size; but, barring the drop in erythrocyte number to 43 per cent of normal, which occurred 9 hours after the initial bleeding and was undoubtedly influenced thereby, his maximum variation appears to have been about 40 per cent. My variations range as high as 67 per cent in No. 4 and No. 12 (not to mention the exceptional cases of No. 2 and No. 17, in the former of which a low volume occurred during a period of tail rot, when the percentage dropped to 11), though in others they are much less than this. Furthermore initial volume is not a very satisfactory base for comparison, for if Baudin's rhythms are valid there is no means of knowing whether the initial value represents a high, a low, or some intermediate point therein. A more satisfactory base would be the average value.

Neither do my observations give any indication of a diurnal variation in concentration of the blood as claimed by Baudin. Examination of many more fish, both by day and night, would be necessary to test this question thoroughly.

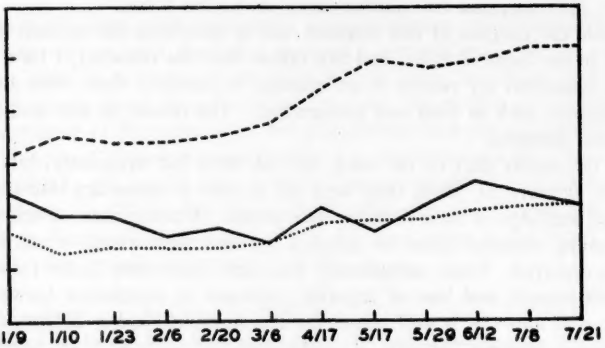

FIG. 1

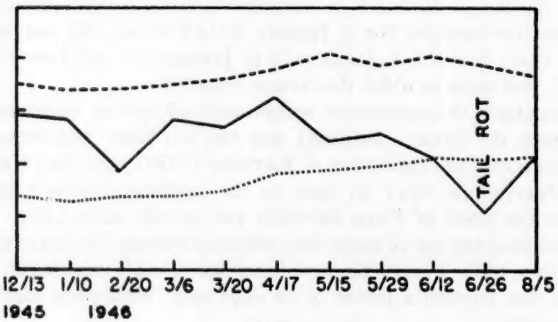

FIG. 2

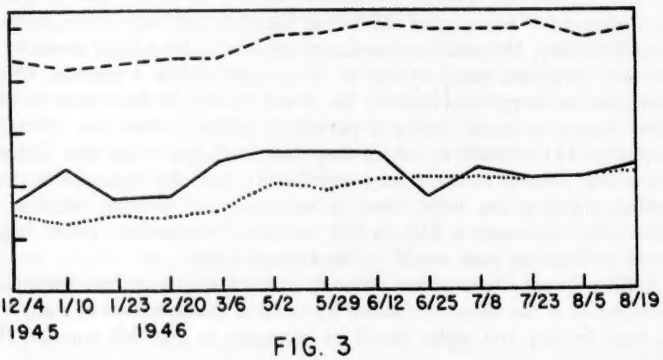

FIG. 3

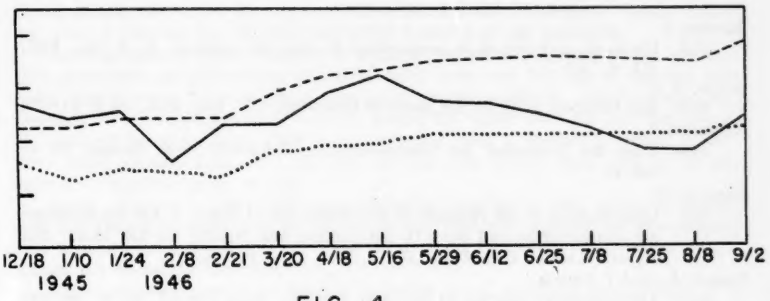

FIG. 4

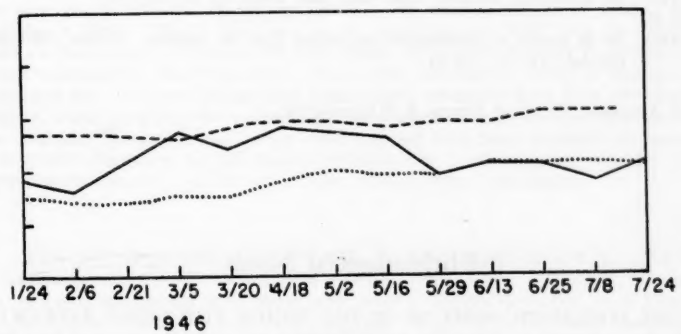

FIG. 5

Figs. 1–5. Showing for five of the experimental fish the relationships between blood cell volume by per cent ——, weight of the fish ---, water temperature in Centigrade . . ., and date of operation. In each graph 1 division = 10 per cent cell volume and 10° C., while the scale of weights in grams is as follows: on Figs. 1, 3, 4 and 5, 1 division = 20; for Fig. 2, 1 division = 40 grams.

A comparison of the variations in relation to sex (omitting the exceptional case of No. 17) shows that the males have an average variability of 52 per cent and the females of 40 per cent. Treated statistically, however, this difference is not significant.

Summary

Observations of the blood cell volume of *Girella nigricans* over periods of a few weeks to several months show that variations in the cell volumes of individual fish are comparable to those observed between different fishes in aquaria. These variations differ in amount in different individuals. No correlation was observed between them and temperature or feeding.

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Ichthyological Notes

THE SYSTEMATIC POSITION OF THE APODAL FISH GENUS *BATHYMYRUS*.—In an attempt to delimit the family Echelidae and revise the genera, I have had the occasion to try to place the genus *Bathymyrus* Alcock (1889, Journ. Asiatic Soc. Bengal, 58 (3), part 2: 305, pl. 22, fig. 6), known only from the type from the Bay of Bengal. I propose the name **Bathymyrinae** for a distinct subfamily of the Congridae containing only this genus. In doing this, I have used as a basis the classifications of Regan (1912, Ann. Mag. Nat. Hist., ser. 8, 10: 377–387) and of Trewavas (1932, Proc. Zool. Soc. London: 656–657). *Bathymyrus* agrees with the Congridae in having the snout produced beyond the lower jaw, the dorsal and anal fins continuous around the posterior end of the tail, and in the lateral position of the posterior nostril. The posterior nostril is a separate and distinct orifice in front of the lower border of the eye (agreeing with the congrid definition), and not a slit or flap in the edge of the upper lip, as in the Echelidae. However, since it does actually penetrate the upper lip, the Bathymyrinae appear to be intermediate between the congrids and echelids.

Bathymyrus differs from both the other Congridae and the Echelidae in having a very short pectoral base placed at the dorsal end of an extremely wide gill-opening. It also differs from all known eels in possessing a great upward and lateral extra-oral expansion of the so-called premaxillaries, studded with small decurved teeth.

If other specimens are obtained and this is found to be not merely a "pug-nosed" individual, as suggested by Myers and Storey (1939, Stan. Ich. Bull., 1 (4): 157), the "extra-oral rostral expansion of the premaxillaries" together with the very wide gill-opening will warrant the elevation of Bathymyrinae to the family level.—James Böhlke, *Natural History Museum, Stanford University, California.*

"HURDLING" BY THE NEEDLEFISH.—While fishing from a bridge over Buck Creek, an inlet off Lemon Bay on the Gulf of Mexico near Englewood, Florida, February, 1949, I observed the following interesting behavior of the needlefish.

An individual of about 10 inches in length swam up to a floating mango leaf, and after deliberately placing the tips of his elongated jaws over the edge of the leaf, propelled himself over. He then swam away, and another needlefish, slightly smaller, approached the same leaf, and after carefully placing his "beak" over the leaf, slid over it. He repeated this twice more while I was watching from a distance of about 15 feet. They didn't actually jump over the leaf, nor did they merely swim over it. It was more of a "standing jump" or slide.

Hubbs (COPEIA, 4, 1948: 298) reported similar behavior for two species of teleosts, and, like Gudger, referred to it as "leapfrogging." This term suggests one fish jumping over another, rather than over an object, so I prefer "hurdling" as less objectionable, though not entirely satisfactory.

Hubbs raised the conjecture whether the action serves to remove ectoparasites, or to provide an outlet for exuberant spirits. My impression is that neither is an entirely correct interpretation. A floating mango leaf would be much too soft and yielding to aid in removing foreign bodies from the needlefish; and the casual, deliberate action doesn't suggest exuberance.

I have caught live fish with my hands by approaching a fish in repose and gradually reaching for it without any sudden motions, and often scratching it gently before grasping it firmly. This is fairly easy to do, particularly at night with the aid of a light on such species as suckers and hog suckers. It sounds incredible to anyone who hasn't witnessed it. Many fish seem to enjoy being scratched or rubbed if they are not frightened first. It seems possible that when surface swimming fishes slide over floating objects, it may be merely for a pleasant physical sensation, much as a cat rubs her back on furniture. Sub-surface and bottom fishes probably have many inconspicuous ways of "scratching" themselves, but the method indulged in by a surface species naturally looks rather spectacular to us.—PAUL L. SWANSON, *RFD 2, Polk, Pennsylvania.*

NEW RECORDS FOR THE PIRATE PERCH, *APHREDODERUS SAYANUS* (GILLIAMS) IN CENTRAL-WESTERN OHIO.—Meek (1888, Proc. U. S. Nat. Mus. 11: 435–440) reported one small pirate perch taken in Gordon Creek near Cecil, Paulding County, Ohio. Trautman (1939, Ohio Jour. Sci., 39 (5): 275–288) stated that Meek's collections were not deposited in the U. S. National Museum. Kirsch (1895, Bull. U. S. Fish Comm., 14 (1894): 315–337) recorded a specimen which he collected in the St. Marys River at Rockford, Mercer County, Ohio. Limited data concerning Kirch's collections indicate that the specimens were not deposited in any museum.

On September 10, 1940, 42 specimens of the pirate perch, ranging from 51 mm. to 93 mm. in length, were seined from the Auglaize River in Allen County, Perry Township, Section 33, and 3 specimens were taken from Camp Creek, in the same general location. Mr. Milton Trautman and I collected one specimen in the Auglaize River in Auglaize County, Union Township, Section 5, on July 9, 1941, and 4 others from the same stream in Auglaize County, Duchouquet Township, Section 14, on October 15, 1941. Specimens from these collections are deposited in the fisheries collections at the Franz Theodore Stone Laboratory, Put-in-Bay, Ohio. On September 24, 1948, one specimen of this species was taken in the Auglaize River in Auglaize County, Duchouquet Township, Section 12. The above collections, made over a period of eight years, seem to indicate a fair population of this species, but seining difficulties prevent the taking of many specimens.

Kirsch (*loc. cit.*) described the location at which he took this species in the St. Marys River as, ". . . . the bottom is soft and everywhere covered with wood, making the seining very difficult." The 42 specimens obtained in the Auglaize River on September 10, 1940, were taken under conditions similar to those described by Kirsch. These pirate perch were secured by seining approximately 300 feet downstream from an operating dredge, in very turbid water. Each seine haul, covering approximately 300 square feet,

recovered almost a half bushel of organic matter in which 7 or 8 pirate perch were usually found. The bottom was deep, soft silt.

Eight specimens were examined for stomach contents. Chironomid larvae were present in four stomachs, immature Corixa in four stomachs, a gyrinid in one and a minnow in one stomach.—CLARENCE F. CLARK, *Ohio Division of Conservation and Natural Resources, State Fish Farm, St. Marys, Ohio.*

THE CAPTURE OF AN ATLANTIC SALMON (*SALMO SALAR SALAR*) IN THE CONNECTICUT RIVER.—At the request of Dr. Russell P. Hunter, Superintendent of the Connecticut State Board of Fisheries and Game, Warden Edward T. Bement brought a salmonid fish to the Bingham Oceanographic Laboratory for identification on June 11, 1948. The specimen had been taken in a haul seine by commercial fishermen William Bennett and John Frazier at Cromwell, opposite Portland on the Connecticut River on the evening of June 10. This point is approximately 30 miles above the mouth of the river.

On examination, the fish proved to be a fresh-run Atlantic salmon (Pl. I) rather than the landlocked *Salmo salar sebago,* which might conceivably have got into the lower Connecticut River as a result of unusually high water conditions that spring. Thus, the least depth of the caudal peduncle was 72 per cent of the distance from the adipose fin to the base of the procurrent, rudimentary caudal rays and 65 per cent of the distance from the anal to the caudal (Hubbs and Lagler, Bull. 26, Cranbrook Institute of Science: 35, 1947; and Kendall, Mem. Boston Soc. Nat. Hist., IX, 1: 137, 1935).

Also, the scales (Pl. I) showed the characteristic marking of an Atlantic salmon which had apparently spent its first two or three years in fresh water and two more (plus part of a third) in the sea. The circuli formed during its fresh-water existence were closely approximated, and the growth in its first year of sea life was over double that of its early years in fresh water. The exact interpretation of the number of years of its fresh-water existence is difficult. Opinion as to whether this phase of the fish's life history occupied two or three years was about divided between a half dozen people who examined the scales independently. Dr. D. L. Belding, supporting the latter view, believes that the third year growth is not so large as would be expected—a condition which, he points out, raises the question of possible estuary growth on a two-year fish, although he feels that the specimen would be considered as a three-year river fish by ordinary scale reading. Dr. A. G. Huntsman, on the other hand, supports a two-year existence in fresh water, with the growth of the first year rather small. He also makes the following interesting observation in regard to this fish's sea life: "In addition to two full years' growth in salt water, there seems to be some growth for the current year, finally slowing down, this in correspondence with what is known for 'summer' fish in Great Britain. It differs from our fish and is probably related to higher sea temperature in winter. This needs study, since grilse always show it."

The fish was a female with a median length (Ricker and Merriman, COPEIA, 1945: 184–191) of 71 cm., or a total length of 73.0 cm. Its weight was reported to have been 7 pounds, 14 ounces at the time of capture. These figures reveal a rate of growth much higher than that of the landlocked form. Cooper (1940, Maine Dept. Inland Fish. and Game, Fish Survey Rept. No. 3: 112–114) observed an average total length of 45.9 cm. for 41 landlocked salmon of age-group V caught during the summer of 1939 in the Rangeley Lakes of Maine. Three landlocked salmon of age-group V caught in the Connecticut River drainage of New Hampshire also had an average total length much inferior (52.6 cm.) to that of the present specimen (Bailey and Oliver, 1939, N. H. Fish and Game Dept., Survey Rept. No. 4: 162). If the present specimen belongs to age-group IV the discrepancy in growth rates is, of course, even more pronounced.

The record of this fish is of particular interest since it appears to be the first positively identified Atlantic salmon in the Connecticut River in approximately a half century. Bigelow and Welsh (1925, Bull. U. S. Bur. Fish., XL, 1: 130–138) stated, "On the American coast salmon formerly ran up all suitable rivers from northern Labrador to the Housatonic River in Connecticut and possibly the Hudson also." They also wrote that, "Although no salmon now spawn south of the Penobscot a few are still taken every

Atlantic salmon taken in the Connecticut River at Cromwell on June 10, 1948, and part of the anterior field of one of its scales.

summer in the weirs in the Massachusetts Bay region." Kendall (*loc. cit.*: 79) cited the fact that there were reports that salmon had been taken in the upper waters of the Connecticut River in 1893. No records of the capture of Atlantic salmon in the Connecticut in the twentieth century are known to us.

A possible reason for the presence of this fish in the Connecticut River may have been the apparently much improved condition of its waters in the spring of 1948. The heavy snowfall of the preceding winter and the consistently rainy spring resulted in an abnormally large run-off, with the result that the river may have been more attractive to a stray individual at the southern end of its range than in other years. It is of some interest in this connection that approximately a week after the capture of this fish, an 11-pound 4-ounce salmon was taken by a fisherman trolling a jointed Pikie-Minnow for striped bass between the red buoy and the north jetty at the mouth of the Merrimack River, Massachusetts; it was apparently the first in years from this region (1948, Salt Water Sportsman, IX, 11: 1).—DANIEL MERRIMAN and YVES JEAN, *Bingham Oceanographic and Osborn Zoological Laboratories, Yale University, New Haven, Connecticut.*

THE ANGEL SHARK, *SQUATINA DUMERIL*, IN SOUTHERN NEW ENGLAND WATERS.—On October 28, 1947, Capt. Ellery F. Thompson, fishing out of Stonington, Conn., on the dragger *Eleanor*, took a single specimen of *S. dumeril* (Le Sueur). The locality, which is seldom fished, is 6 miles S. E. of Pt. Judith, R. I., the depth 17 fathoms, and the bottom smooth but adjacent to a rocky area. Capt. Thompson shipped the fish to New Haven that night, and it was identified and examined in some detail by us the following day.

Bigelow and Schroeder (Fishes of the Western North Atlantic, Mem. Sears Found. Mar. Res., 1 (1), 1948: 538–544) stated:

> This is a summer visitor to the mid-Atlantic coast of the United States. . . . . To the northward it has been reported between May and October from Chesapeake and Delaware Bays, and from various localities along the coast to the vicinity of New York, as well as in the bays along the southern shore of Long Island. . . . .Three specimens have been reported from Rhode Island, two from the vicinity of Woods Hole, this last being the most easterly and northerly record for it.

The present specimen measured 120.5 cm. (47.5 in.) to the tip of the lower lobe of the caudal fin, 118.5 cm. to the tip of the upper lobe, and 114.5 cm. to the middle of the fork. Its weight was 15.7 kg. (34.5 lb.). The fish was a female—at least, as judged by the absence of claspers (see below).

Examination of the viscera revealed the following facts. The weight of the liver was 587 g. The stomach contents were: unidentifiable material (amorphous and semi-fluid) —197 g.; 1 stone (20 mm. in diameter); 2 pieces of onion; 1 *Cancer irroratus* (carapace length 22 mm., width 29.5 mm.); several pieces of fish flesh; 2 sections of fish vertebral column; and 14 spherical objects 5–8 mm. in diameter which were almost certainly the crystalline lenses of cod (*Gadus morhua*) (see Vladykov, Contr. Inst. Biol. Générale et Zool., Univ. Montréal, 19, 1947: 47 and 80), a species which is common in the area at the time this specimen of *S. dumeril* was taken.

The genital organs were particularly interesting in the fact that there was apparently only one functional ovary, the left. Daniel (The Elasmobranch Fishes, Univ. Calif. Press, Berkeley, 1934: 303) pointed out that it is the left ovary that frequently atrophies in certain genera, although he made no mention of *Squatina*. In this specimen the left ovary weighed 317 g. (0.7 lb.) and contained eggs of different sizes up to approximately 3.5 cm. (1.4 in.) in diameter. What appeared to be the right gonad was relatively small, flattish and inconspicuous and had the typical appearance of an immature elasmobranch organ. Although fixation was inadequate, sections of this gonadal material provided considerable evidence that the organ was an immature testis rather than an indifferent early stage, or suppressed, gonad. The specimen may, therefore, have been partially hermaphroditic, and in all events, the development of the left ovary is unusual because it is the reverse of the more typical asymmetry cited by Daniel. There were no developing embryos in either of the genital tracts, which were equally well developed and completely normal in appearance.

Further observations on the internal anatomy of *Squatina dumeril* should be of much interest.—Daniel Merriman and Yngve H. Olsen, *Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut.*

A CASE OF POISONING BY A STINGING CATFISH IN THE PHILIPPINES.—It is well known that many fishes, mainly tropical, are highly venomous. Spines on the head and body, but particularly the dorsal and pectoral spines, have venom glands which discharge their poison whenever a spine is touched.

The family Scorpaenidae contains more kinds of venomous fishes than any other group. Many cause excruciating and almost unbearable pain, while several species may cause a horribly agonizing death in from one to four hours. The sting rays, both marine and fresh water, are another group of justly feared venomous fishes.

Very many catfishes, belonging to a number of families and occurring in both salt and fresh water, are more or less venomous. Some of the most dangerous species belong to the Plotosidae, a small family of Indo-Pacific marine and fresh water catfishes, ranging from the Red Sea to southern Japan, Australia, and Polynesia. All have a small head, a short body, and an elongate tapering tail; the long anal and second dorsal are confluent with the small pointed caudal.

The following is an account of the effects of the sting of *Plotosus anguillaris* (Bloch). On the afternoon of July 12, 1948, I was fishing among coral heads off the city of Dumaguete, Negros Oriental Province, Philippines. Three divers were helping me, while I sat in the *banka* taking care of the fish as they dumped them into the boat. I had always used forceps to pick up venomous fishes, but the day before a stupid clerk had thrown away my only pair of large forceps.

On the floor of the *banka* was a plotosid about 145 mm. long. It has lain there motionless and apparently dead for a good while, probably fifteen minutes. Having gathered all the other fish within reach, I thought it would be safe to pick up the dead *Plotosus*. As soon as I lifted it by the tip of the tail, it began to jerk violently from side to side, and before I could drop it, had run a pectoral spine into the inner side of my right thumb opposite the middle of the nail. Apparently this was the dying throe of the fish, as it continued to lie as if lifeless when dropped.

The pain was very great, but not unbearable, and I thought it would abate after a while. We kept on fishing for another half hour, then landed and walked to Science Hall at Silliman University, about three-quarters of a mile away. There I put away my fish, bathed and changed clothes, while the pain steadily grew worse as my hand began to swell. At the University hospital, a physician put on a bandage and gave me a sleeping tablet, two futile gestures. I did not sleep any that night, and in the morning my hand (except the little finger), the wrist, and part of the forearm were swollen to more than twice their usual size.

That forenoon another doctor slashed open the wound and put in a drain, then shot morphine into me. My hand was dressed twice a day for a week, and the swelling did not spread any further. After five days it began to go down very slowly. In the meantime, the local symptoms were followed on the third day by a general systemic disturbance which violently affected the intestinal tract. For three days there was a very severe attack of diarrhea, which ceased on the sixth day and caused a loss in weight of nearly 25 pounds.

The thumb healed very slowly. A month later I was still unable to use it, and the closed wound was very painful to the touch. Two months later the wound looked to be healed, but I had to be very careful in using my thumb. The least pressure caused much pain. It took five and a half months for the thumb to be fairly well healed so that it could be used freely. Even yet the place where it was wounded is unduly sensitive.

It is evident that *Plotosus anguillaris* is a far more venomous fish than any of the North American catfishes. I have been stung many times by the common catfishes of this country, including the mad toms. The pain always stopped in a few minutes, and there never was any swelling.—Albert W. C. T. Herre, *School of Fisheries, University of Washington, Seattle, Washington.*

Herpetological Notes

LONGEVITY OF SNAKES IN CAPTIVITY IN THE UNITED STATES.—This list contains what records are available to us. There surely are better records as well as ten-year records of other species and we would be very pleased to hear from anyone having such information. We intend to bring the list up to date each year as of the first of January.

Only the oldest snake of each species, or subspecies, is listed. An asterisk indicates that the specimen was alive on January 1, 1949.

This list contains the same snakes as in last year's list (COPEIA, 1948: 217) brought up to date and new records added.

Species	Location	Years	Months
**Agkistrodon contortrix mokeson*	Brookfield Zoo	12	7
**Agkistrodon piscivorus*	R. M. Stabler	13	8
Boa annulata	Phila. Zoo	12	4
Boiga dendrophila	St. Louis Zoo	11	9
Constrictor constrictor constrictor	Phila. Zoo	12	3
**Constrictor constrictor imperator*	San Diego Zoo	11	3
Crotalus adamanteus	No. Carolina St. Mus.	14	9
**Crotalus atrox*	San Diego Zoo	12	7
Crotalus basiliscus	San Diego Zoo	10	1
Crotalus horridus horridus	Syracuse Univ.	13	0
**Crotalus ruber ruber*	San Diego Zoo	11	5
**Crotalus tortugensis*	San Diego Zoo	11	9
**Crotalus viridis helleri*	San Diego Zoo	11	10
**Crotalus viridis viridis*	San Diego Zoo	10	1
Drymarchon corais couperi	Robert Riggs	12	11
Dendroaspis viridis	St. Louis Zoo	11	3
**Elaphe guttata*	Phila. Zoo	19	4
**Elaphe obsoleta obsoleta*	Amer. Mus. Nat. Hist.	11	6
**Elaphe obsoleta quadrivittata*	San Diego Zoo	11	7
Epicrates angulifer	Washington Zoo	11	9
**Epicrates cenchria crassus*	Staten Island Zoo	11	2
Epicrates cenchria maurus	Bronx Zoo	27	4
Epicrates striatus	Phila. Zoo	16	0
Eunectes barbouri	Phila. Zoo	13	11
Eunectes deschauenseei	Phila. Zoo	13	10
Eunectes murina	Washington Zoo	28	0
Helicops schistosus	Phila. Zoo	12	3
**Lampropeltis doliata amaura*	Geo. P. Meade	12	7
Lampropeltis getulus brooksi	San Diego Zoo	10	0
**Lampropeltis getulus californiae*	San Diego Zoo	12	1
Lichanura roseofusca roseofusca	San Diego Zoo	12	0
**Masticophis flagellum piceus*	San Diego Zoo	10	8
**Masticophis flagellum testaceus*	San Diego Zoo	12	2
**Naja melanoleuca*	San Diego Zoo	20	3
Naja naja	Phila. Zoo	12	4
Naja naja atra	Brookfield Zoo	10	3
**Naja nigricollis*	Brookfield Zoo	14	2
**Naja nivea*	San Diego Zoo	11	11
**Ophiophagus hannah*	Wiley Zoo	11	5
**Pituophis catenifer annectens*	San Diego Zoo	12	4
**Python curtus curtus*	St. Louis Zoo	15	7
**Python molurus bivittatus*	Phila. Zoo	13	6
Python molurus molurus	Phila. Zoo	13	0
Python reticulatus	St. Louis Zoo	20	0
**Python sebae*	Phila. Zoo	12	1
Sistrurus catenatus	Tabor College	14	0
Ungaliophis guatemalensis	Grace O. Wiley	17	8

C. B. PERKINS, *Zoological Society of San Diego, San Diego, California.*

ON THE DORSAL SAIL OF *DIMETRODON*.—The remarkable development of the vertebral spinous processes that formed the framework for a membranous sail-like structure in certain large Permian reptiles (*Dimetrodon* and *Edaphosaurus*) has excited considerable comment. Suggestions as to the function of this structure, which markedly increased the body height and surface area of the reptile, have been based on its possible utility for defense, as a support for the vertebral column (Romer and Price, 1940, Geol. Soc. Amer. Sp. Paper, 28: 107), and as an aberrant, senescent, evolutionary development which served no survival function. However, since *Dimetrodon* was the dominant predator of its period, and since the structure was supported by fragile spines, it would appear to have had little value for defense or structural strength. The lack of muscular reaction centers in the spines is evidence that these structures had little supportive function. Romer and Price point out that *Dimetrodon* is the commonest animal from the bottom to the top of the bone bearing Texas redbeds, representing a period of several million years, and they remark, "If *Dimetrodon* is senescent, racial decrepitude would appear to be a blessing." The fact that at least two different types of spine bearing reptiles appeared and disappeared at approximately the same geological period suggests strongly some role of environmental factors that gave the spines significant survival value.

Our recent investigations of the body temperature—blood pressure relationship (Rodbard, 1948, Science, 108: 413) have led us to an analysis of the evolution of the regulation of body temperature, and these studies have suggested a possible function for the hypertrophied spinous processes. These studies have re-emphasized the fact that terrestial poikilotherms are dependent upon solar heat to raise their body temperatures to levels at which they can function adequately. Thus amphibians and reptiles at temperatures near freezing are immobile and incapable of carrying on the functions necessary for defense, nutrition and reproduction. Warming by the sun during the day raises body temperature and increases the rate of metabolism of these heliotherms and thus enables them to carry on their vital processes.

A number of facts point to the utility of the spinous processes of *Dimetrodon* and *Edaphosaurus* in the absorption of solar radiant energy. These pelycosaurs stand in close phyletic relationship to the therapsid proto-mammalian reptiles. In the absence of heat conservation mechanisms, the relative frigidity of the Permian period probably placed a premium upon the ability to absorb solar heat. Particularly would this be true in animals of large bulk in which the absorptive surface area is small compared to the mass to be warmed. An increase in the surface area exposed to the sun would result in a more rapid increase in body temperature to levels optimal for function. The fact that many of the spines are grooved anteriorly and posteriorly for much of their length with many channels leading in the direction of the web suggests that these grooves carried blood vessels (Romer and Price, and, in personal discussion, E. C. Olson). The interspinous web could thus have served admirably to increase the absorption of solar heat, especially during the early part of the morning when the sun's rays were perpendicular to the spines. The spines might also have functioned as radiators to lose heat, but the chilliness of the Permian probably made such a mechanism of little importance compared with their value in heat absorption.

The fact that no comparable hypertrophy of the dorsal spines is known to have existed at any other period suggests that a combination of special climatic and ecological conditions contributed to the development and decline of these types. The more temperate climate of the succeeding Triassic probably rendered the sail unnecessary, even dangerous. Under conditions of climatic warmth, the possession of a heat-absorbing surface would no longer have survival value. With the development of other predatory reptiles and of the early mammals, the highly vascularized, fragile, vulnerable sail may have contributed to the extinction of the sail-bearers.

The dorsal spines of *Dimetrodon* and *Edaphosaurus* may thus be interpreted as suggestive evidence for the early utilization of circulatory mechanisms for the control of body temperature.—Simon Rodbard, *Michael Reese Hospital, Medical Research Institute, Chicago, Illinois.*

OBSERVATIONS OF THE FEEDING HABITS OF THE JUVENILE CANTIL.—Recently an adult 30-inch cantil, *Agkistrodon bilineatus,* was shipped to me from Mexico and somewhere enroute she gave birth to a brood of 8 baby snakes. Evidence in the shipping box indicated that they had been born about thirty hours prior to their arrival on July 6, 1948. Upon arrival four were dead but the remaining four were healthy and in good condition. Unlike most snakes, the new born young of the *Agkistrodon bilineatus* closely resembles the full grown adult. On August 1, 1948, the appearance of these baby snakes was as follows: ground color of the body dark brown; thirteen cross bands darker brown in color; bands on the sides edged with half scale white spots separated by one to three scale rows; ventrals dark grey with white dotlike spots near the sides from midway to the throat; head dark brown with two enamelike white stripes on either side; snout pointed; upper white stripe extending from nose to eye and from eye to end of the upper jawbone; lower white stripe on the upper labials.

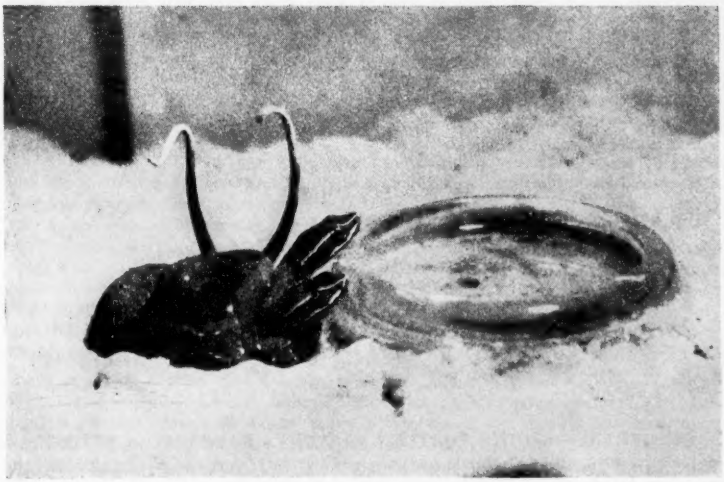

Fig. 1. Typical tail lure position of juvenile cantils.

The tail was bright yellow for 3 cm. from the tip and on both sides, and the extreme end was grey, giving an unmistakable appearance of a yellow caterpillar with a head. The remainder of the tail was the same shade of brown as the body, and the caudals were pale grey.

The measurements of the juvenile cantil were: total length 257 mm., head and body 199 mm., tail 58 mm. Fangs were 4 mm. in length and 7 mm. apart at the base.

The arrival of the baby cantils gave me an unusual opportunity to observe the feeding habits of the species when they were but a few days old. Their method of attracting prey was fascinating. I kept them in a terrarium at the Reptile Institute where I could make notes on their activities daily. The juvenile *Agkistrodon bilineatus* carries its tail in a vertical position with the yellow tip in intermittent motion. It resembles nothing so much as a wriggling worm twisting about hungrily in search of food. To observe the effectiveness of this lure in actual practice, on August 1 I placed a green tree frog, *Hyla cinerea,* in the terrarium with the snakes. When the frog, attracted by the lure, hopped close to one of the baby cantils, the snake struck with lightning like swiftness. Shortly thereafter the hind leg of the frog became stiff and within an hour and ten minutes the frog died. I noted that the places on the leg and body where the

frog was bitten were very black from coagulated blood, indicating the hemo toxic properties of the venom. The snake did not attempt to eat the frog. On August 2 I put a chameleon in the terrarium and almost at once it was bitten by one of the baby snakes. It let go immediately when the chameleon bit the snake in retaliation. The lizard died in 1½ hours. Once again the site of the bite was black with coagulated blood. On this same day, I introduced four oak toads, *Bufo quercicus,* into the terrarium. The toads were completely enchanted by the provocative lures. In their excitement they hopped over the snakes, completely oblivious of the danger, snapping repeatedly at the tails, especially when the tails were lowered to within reach. However, the snakes made no attempt to kill the toads. Eight days later on August 10, four tree frogs, *Hyla squirella,* were placed in with the juvenile cantils. One frog was immediately enticed by one of the tails and bit at it several times. When one of the snakes struck at it, it missed. Two hours later two frogs were caught and eaten. For the next two days, the tails of the snakes that had eaten were kept down, apparently indicating that the tail lure is only utilized by the snake when in quest of prey. More frogs were tried, but I could not induce the snakes to eat them even though the tails were kept up and moving constantly. It was apparent then that I did not have the right kind of food available.

I made the following observations with regard to tail action. Tails were held up from 2–2½ inches and were very active when food was nearby. The report from my notes of August 1 is as follows:

8:30 A.M.	Tails up on all four	6:00 P.M.	Tails up on two
10:15 A.M.	Tails up on two	7:15 P.M.	Tails up on three
1:15 P.M.	Tails up on three	9:00 P.M.	All tails down

On August 2, I made these observations:

9:20 A.M.	Tails up on two	10:00 P.M.	All tails down
6:00 P.M.	All tails down	12:00 Midnight	All tails down

It seems likely that the juvenile *Agkistrodon bilineatus* keeps the tail down at night.

One preserved specimen was sent to Chicago Natural History Museum, and three live specimens were forwarded to the Staten Island Zoo for exhibition.—E. Ross Allen, *Reptile Institute, Silver Springs, Florida.*

OCCURRENCE OF THE TURTLE *GRAPTEMYS BARBOURI* IN GEORGIA.—On June 26, 1948, an adult female specimen of *Graptemys barbouri* Carr and Marchand was taken D.O.R. about 12 miles southwest of Newton, Baker County, Georgia. The road, unpaved and not well traveled, is about 100 yards from Ichauwaynochaway Creek and is parallel to it. Another large terrapin, presumably the same form, was observed (June 29, 1948) swimming in the same stream at a point some 100 yards above the location of the D.O.R. specimen.

The presence of this form in southwestern Georgia is not surprising. Ichauwaynochaway Creek is a tributary of the Flint River before the confluence of the Flint with the Chattahoochee to form the Apalachicola. Carr and Marchand (1942, Proc. New England Zool. Club, 20: 95–100) described the species from material taken along the Chipola River, a tributary of the Apalachicola. The collection of *Graptemys barbouri* in Baker County indicates a northward and eastward extension of the known range of this species by some 50 miles.

Brimley (1910, Proc. Biol. Soc. Wash., 23: 9–18) reports a single example of *Graptemys pulchra,* a name now invalid, from Mimmsville, Baker County, Georgia. Dr. Archie F. Carr has suggested in a personal communication that *Graptemys pulchra* may be synonymous with *G. barbouri.* In so far as we have been able to determine, the Brimley specimen is not in existence at the present time.

The specimen of *Graptemys barbouri* is deposited in the collection of the Zoology Department of the University of Georgia. We wish to thank Dr. Coleman J. Goin, of the University of Florida, for confirming the identity of this form.—John W. Crenshaw, Jr., and George B. Rabb, *Emory University Field Station, Newton, Georgia.*

THE STATUS OF BAIRD'S CHORUS-FROG.—In the fourth edition of the *Checklist,* Baird's chorus-frog was listed as *Pseudacris nigrita feriarum,* but in the fifth edition it was given full specific rank, although *triseriata, septentrionalis, verrucosa,* and the specifically distinct *clarkii* were still listed as subspecies of *P. nigrita.* Possibly this action was predicated upon records suggesting that the range of *feriarum* overlapped that of some other member of the *nigrita* group. However, the resultant arrangement is unsatisfactory.

In the first place, *feriarum* is scarcely distinct from *triseriata,* if indeed the two are not synonymous. The leg of *triseriata* is said to be slightly shorter, and the dorsal stripes of *triseriata* are supposedly somewhat wider. The two have so often been confused that it is impossible to determine their respective ranges from the literature. The fifth edition of the *Checklist* gives the range of *feriarum* as "New Jersey, Pennsylvania, and possibly into South Carolina and northwestern Florida"; *triseriata* is stated to range from New York west to Idaho, south to Louisiana. Conant, however, lists the chorus-frogs of Delaware and the Eastern Shore counties of Maryland and Virginia as *triseriata,* crediting the identification to C. H. Walker (1945, An annotated checklist of the amphibians and reptiles of the Del-Mar-Va Peninsula: 3). Ackroyd and Hoffman call *feriarum* "the common Virginia species" (1946, Copeia, 4: 257). Taylor records *feriarum* from Arkansas (1935, Univ. Kansas Sci. Bull., 22: 209); Black and Dellinger quote Taylor's record but otherwise list only *triseriata* from Arkansas (1938, Occ. Pap. Univ. Arkansas Mus., 612: 18).

A form of upland chorus-frog ranges at least from the higher areas of Virginia southward through the Piedmont of North Carolina, South Carolina, and Georgia. This frog has generally been called *feriarum* (Chamberlain, 1939, Charleston Mus. Leaf., 12: 16; Ackroyd and Hoffman, *op. cit.*: 257; Hoffman, 1945, Herpetologica, 2: 201; Neill, 1947, Copeia, 4: 272; etc.). Presumably it ranges farther north, to Carlisle, Pennsylvania (the type locality), and beyond (cf. Pawling, 1939, Herpetologica, 1: 167). The taxonomic and geographic relationship of this frog to *triseriata* remains to be worked out; but certainly the Piedmont form, generally accepted as *feriarum,* meets and intergrades with typical *nigrita* along the Fall Line of Georgia and South Carolina.

The dark or spotted coloration and the proportionately greater leg length and sharper snout of *nigrita* develop almost imperceptibly in the Fall Line region. Thus, specimens from upper Columbia County, Georgia, consistently display *feriarum* form and coloration, while those taken 10 or 15 miles farther south, on the northwestern side of Augusta, Richmond County, are occasionally of *nigrita* coloration, although of *feriarum* proportions (cf. Neill, *op. cit.*: 272). Series collected on the southeastern or Coastal Plain side of Augusta contain a higher percentage of specimens of *nigrita* coloration. About 10 miles below this point, near Tahoma, Richmond County, one encounters the first suggestions of *nigrita* form; *feriarum* coloration still predominates. About 5 to 10 miles farther south, in southern Richmond and northern Burke counties, some specimens could be called typical *nigrita* and others are intermediate. The influence of *feriarum* is not evident below Burke County; series from Screven County southward are typical *nigrita.* A similar situation exists in South Carolina, *feriarum* occurring in Edgefield and upper Aiken counties (Piedmont), intermediates in lower Aiken and Barnwell counties (near the Fall Line), and *nigrita* from Allendale County southward.

Accordingly, I believe that the Piedmont chorus-frog should be known as *Pseudacris nigrita feriarum* (Baird). Indirect evidence confirming this contention is the fact that *feriarum* is a logical development in the chorus-frog complex, standing intermediate between the blunt-headed, short-legged, striped populations to the northwest, and the acuminate-headed, long-legged, spotted populations to the southeast.

The occurrence of *P. n. feriarum* in the Apalachicola ravines of northwestern Florida is not inconsistent with this allocation (Carr, 1940, Univ. Fla. Pub., 3: 56). The western portion of the Georgia Coastal Plain is considerably higher than the eastern, rising to altitudes of 650 to 700 feet between Macon and Columbus. The western portion of the Fall Line Hills, 350 to 700 feet in elevation, merge into the relatively high Dougherty Plain, which is sharply differentiated from the Altamaha "Upland" to the east and south (Veatch and Stephenson, 1911, Geol. Surv. Georgia, 26: 27 *et seq.*). Numerous lowland

species avoid this higher inland area, even though perhaps ranging to the Fall Line in eastern Georgia; and conversely, many essentially Piedmont forms (among them *P. n. feriarum*) invade the Coastal Plain for varying distances along this strip of country. The occurrence of various upland species in the Coastal Plain of western Georgia and northwestern Florida is probably attributable in part to the topography and in part to the lack of competition that results from the absence of numerous Coastal Plain forms. The hilly and dissected terrain of Liberty, Gadsden, and Jackson counties, Florida, has many species of plants and animals that have reached the area via the higher western Coastal Plain of Georgia.—WILFRED T. NEILL, *Department of Biology, Augusta Junior College, Augusta, Georgia.*

TWO CASES OF SNAKE BITE IN NEW GUINEA.—On December 2, 1943, I was preparing to give a lecture to a group of men who were assembled before my tent in a clearing about 10 miles north of Port Moresby, Papua. Suddenly a large specimen of the elapid snake, *Demansia olivacea,* dashed from the surrounding *kunai* grass into the midst of the gathering. At the time I had several large captive examples of the form, and took the snake to be an escape. Fearing an accident for which I might be indirectly to blame, I pounced upon the reptile and attempted to seize its head before it could bite. Such efforts were unavailing; the snake embedded both fangs deeply in the middle joint of the third finger of my right hand. Previous observations on the feeding habits of the form had convinced me that it was not dangerous to man, even though its congener, *D. textilis,* is reputedly a deadly species. Accordingly I did not treat the bite, but continued with the work of the day.

The bite occurred at 1:00 P.M. By 1:05 considerable erythema and edema were evident in the bitten finger. By 1:10 the swelling had begun to involve the adjacent fingers; and by 1:25 all the digits, the back of the hand and the palm were swollen. By 1:45 the swelling had progressed about half way up the forearm. Edema was never so pronounced as in bites from crotalid species, and the affected parts did not pain greatly. The area about each fang puncture was a dead white and quite insensible to touch. No further symptoms were evident at 2:30, and by 3:30 the swelling had subsided markedly. Expecting no further manifestations, I set out about 5:00 P.M. for a nearby lagoon where I had been observing a colony of *Crocodylus novae-guineae.* I hiked briskly across about 4 miles of grassland and scrub, arriving at the lagoon around 6:30. Apparently the stimulation of circulation engendered by the walk hastened the absorption of some neurotoxic element that had not manifested itself previously. Rather abruptly I experienced an odd loss of co-ordination in lateral movements of the arms and legs. Balance and walking ability were not affected; difficulty was experienced in reaching out and grasping an object; stepping over tangled roots and vines became well-nigh an impossibility. Shortly thereafter I felt an unpleasant sensation as of pressure upon the backs of the eye-balls. Simultaneously breathing became difficult and vision was slightly impaired. I walked slowly back to camp and retired. The following morning at about 6:00 A.M. I felt completely well, all symptoms having disappeared save for a slight swelling and tenderness in the palm of the hand; these too disappeared during the day.

It might be added that the snake turned out to have been a wild specimen, not an escape. About half an hour after the bite took place, I discovered a large monitor lizard (*Varanus* sp.) rooting about in the grass a few yards behind my tent. Possibly this ophiophagous reptile had frightened the snake, and the latter had dashed into our midst unwittingly. It is unlikely that the snake was deliberately attacking, although the species is aggressive and ill-tempered, reminding one much of *Coluber c. constrictor* in disposition, agility, speed, habits and form. Upon preservation the snake proved to be a male 44 inches in length.

In previous years I had been bitten by various American crotalids; whether this had conferred any degree of immunity to elapid bites is uncertain. Since the snake was quite large for its species, and its bite a "successful" one, it may be presumed that *Demansia olivacea* (and the probably conspecific *D. psammophis*) are not dangerous to man.

Near Nadzab, in the Markham Valley of northeast New Guinea, I suffered another unpleasant snake bite, oddly enough from a supposedly harmless colubrine snake. Walking about in a patch of jungle, I noticed a small tree snake, *Ahaetulla papuae*, lying in a tangle of vines. I managed to grasp the snake, and it retaliated by biting down upon the little finger of my right hand. The snake was a very small specimen of its kind, scarcely 18 inches long, and its tiny teeth were unable to break the skin. It retained its hold, however, chewing away with a great show of ferocity. I walked back to camp with the little reptile, amused by its bull-dog efforts. Somewhere along the way its enlarged posterior maxillary teeth must have penetrated the skin, although I felt no sensation. About 10 minutes later I noticed two tiny punctures in the skin where the little creature had bitten. Within another 10 minutes the finger was red and swollen, with a white spot about each tiny puncture. The swelling progressed rapidly, within an hour's time involving the digits, palm, back of the hand, and most of the forearm. Pain was intense, much more so than in the *Demansia* bite, but still less than in most crotalid bites. No further symptoms developed except a painful swelling in the axilla of the bitten arm. The pain and swelling slowly subsided during the next four days, but the bitten finger remained tender for fully a week. I had been bitten many times by 3- and 4-foot adults of *A. papuae* with no ill effects beyond a few small scratches; however, the larger specimens were never permitted to retain their hold or to embed the large back teeth for any length of time. Of course, some idiosyncratic reaction is possible, but this seems unlikely. It seems probable that other supposedly harmless snakes may have toxic salivas that are injected into prey by means of the enlarged rear teeth.—Wilfred T. Neill, *Department of Biology, Augusta Junior College, Augusta, Georgia.*

THE YOUNG OF THE LIZARD *SCELOPORUS POINSETTII*.—A female *Sceloporus poinsettii* Baird and Girard taken 40 miles east of Fort Stockton, Texas, on June 3, 1949, gave birth to seven young on the following June 6. Three of the young lizards had been born when the event was discovered. The female was immediately removed from the sack in which she had been kept since capture, and placed in a cage. The record from that time on follows:

3:20 P.M. (estimated). Female placed in cage.
4:20 P.M. Two additional young, one still wet.
4:40 P.M. One additional young and a bad egg.
4:50 P.M. Another young lizard (partly emerged) clinging to mother's leg.

The entire process required from an hour and a half to two hours, but the disturbance to the mother in transferring her to the cage may have increased the time somewhat. The young lizards emerged free of any membraneous sac and were able to scamper about as soon as they had dried. Their behavior was much like that of the adult. That is, they would remain motionless, clinging to the floor or walls of the cage until disturbed, when they would quickly dash away.

The young lizards were in general marked like the adult, but the pattern was much more distinct. The dorsal blotches had the appearance of crossbands extending well down the sides. These were connected medially by a narrow dark band running from the nuchal collar to the base of the tail. In some of the little lizards this band gave the appearance of a mid-dorsal dark stripe. The rings on the tail were very distinct. The head appeared mottled, somewhat lighter in color than the dorsal blotches, but most of the specimens displayed a small roundish spot between the eyes, a light band across the head just in front of the eyes, and a smaller and less distinct light crossbar just in front of that one.

The measurements of the young lizards (alive) were: snout to vent length, 30–32 mm., average (6 specimens), 31 mm.; total length, 67–69 mm., average (4 specimens), 68 mm. The adult was s-v 105 mm., total length 248 mm.

Three of the young were kept alive, and it was found that they would accept flies, small grasshoppers, and a few ants as food.—L. W. Ramsey and E. T. Donlon, *Texas Christian University, Fort Worth, Texas.*

NOTES ON THE YOUNG OF THE BLUE RACER, *COLUBER CONSTRICTOR FLAVIVENTRIS*.—On July 16, 1947, I received a batch of 18 snake eggs found in a decaying pile of wood pulp in Lafayette Parish, Louisiana. Eleven of them were in good condition, and the other 7 were damaged. I kept them all in the decaying pulp in the hope that the warmth would make them hatch.

Four days later, July 20, the first of the eggs to hatch produced a young blue racer (*Coluber constrictor flaviventris* Say). It was nervous and aggressive, and it would strike at the least movement before it. It was 299 mm. (11 $\frac{13}{16}$ inches) long at birth. On the fifth day, July 21, 4 more eggs hatched, and the sixth day, July 22, the remaining 6 eggs hatched, giving me a total of 11 young snakes. All of them were as nervous and aggressive as the first, but after the first few days of handling they lost these characteristics.

The largest of the eleven at birth was 310 mm. (12 $\frac{3}{16}$ inches) long, and the smallest was the first born. Of the 11 only 2 measured more than 305 mm., and the average for the 11 was 302 mm. (11 $\frac{14}{16}$ inches).

The eleventh day after hatching, 2 of the young shed their skins. The twelfth day 5 more shed and the other 4 shed their skins on the thirteenth day. On September 6, 7 of them shed again, and on September 8, the remaining 4 shed. All were very beautiful after shedding.

For nine days after the first egg hatched, the young would not eat though a wide variety of insects and small frogs was offered them. On the tenth day I offered several small chameleons (*Anolis carolinensis*). The snakes went after them with a rush, and in about four minutes all the chameleons were gone. Chameleons were plentiful around the house, and I caught quite a few for the snakes to feed on. They also ate three ground lizards (*Leiolopisma laterale*), although they did not attack them as voraciously as they did the chameleons. The chameleons were usually engulfed head first, but sometimes tail first.

On September 9, while feeding chameleons to the snakes, an example of cannibalism was observed. One of the snakes struck at a chameleon and missed and caught another snake right behind the head. The striking snake then started maneuvering the other snake's head so that it would go down straight, and started swallowing it. Very little struggle was put up by the snake being swallowed. They were approximately the same size, and the engulfment took twenty-two minutes for completion. The snake eaten seemed to be pressed into a series of curves so as to fit into the body of the other snake.

Two days later, September 11, the same thing happened in a slightly different way. A chameleon was being swallowed by 2 snakes at the same time, one at the head, and the other at the tail. When the snakes' heads met, the one coming from the tail end caught the head of the other in its jaws and kept up the swallowing process until the other snake disappeared down its throat.

Of the remaining brood all except 2 (which were preserved) were liberated in Lafayette Parish, Louisiana, on September 18, 1947.—Ernest A. Liner, *Southwestern Louisiana Institute, Lafayette, Louisiana.*

THE TOAD *BUFO VALLICEPS* IN ARKANSAS.—A single adult specimen of *Bufo valliceps* Wiegmann (Univ. Ill. Mus. Nat. Hist. No. 591) was secured by Robert L. Hass, on the night of May 3, 1948, during a heavy shower, which brought out large numbers of salientians of other species, near Calion, Union Co., Arkansas. While known from the "hill country" of adjacent Louisiana, the species has not previously been known to occur in Arkansas. The specimen measures 64 mm. snout to vent; its features are unmistakably those of *B. valliceps*, including among the more distinctive a profusely spotted throat and chest, a large parietal crest, a subtriangular parotoid gland, an oblique series of tubercles on each side, a very dark brown ground color, a lateral light stripe and a median light stripe.—Hobart M. Smith and Dave A. Langebartel, *Museum of Natural History, University of Illinois, Urbana, Illinois.*

EARLY BULLFROG TRANSFORMATION.—During the past two years observations were made on the faunal development in three newly constructed farm ponds located in Davis County, southeastern Iowa. Of special interest were the bullfrogs (*Rana catesbeiana* Shaw) in one of the impoundments. This pond was completed late in July, 1946, received its first water in mid-September and was completely filled the following spring. The impoundment has a surface area of about 0.7 acres and a maximum depth of about 19 feet. It was constructed so that one-third would have a depth less than 4 feet and two-thirds less than 9 feet. In the fall of 1946 the entire watershed was limed and fertilized (3–12–12). In addition, the disturbed areas were seeded and heavily mulched with timothy straw.

Following the construction two large seepages were noted in the deep portion of the pond. And, during the winter of 1946–47 when there was about 12 feet of water, two spots did not freeze, indicating a source of warm water. No such openings were present during the winters after the pond was filled.

By the summer of 1948 aquatic insects, crustacea and algae were abundant. Reed canary grass (*Phalaris* sp.), cattail (*Typha latifolia*), pondweed (*Potamogeton* sp.) and arrowhead (*Sagittaria* sp.) had become established.

There were no permanent or temporary ponds or streams on the watershed from which bullfrog eggs or tadpoles could have entered the pond following construction.

During the spring and summer of 1947 several adult bullfrogs were seen at the pond site though none had been stocked. Two sources, a small permanent pond and a stream from which adult frogs could have migrated, were less than 40 rods distant. In October, 1947, fry of large mouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*) and bullhead (*Ameiurus* spp.) were stocked by the Iowa State Conservation Commission. No frogs were included in this stocking.

Hundreds of large tadpoles were noted in the shallow sections of the pond in the spring (May) of 1948. Those checked in July ranged in length from 4.1–5.9 inches. On June 16, 1948, the first evidence of transformation was detected. By July 1, a large number were in the transformation stage and by August 1, 1948, only a few tadpoles remained. Specimens collected were identified as bullfrogs (identification verified by Dr. Charles F. Walker, Associate Curator of Reptiles in the Museum of Zoology, University of Michigan). These data would indicate that only one winter was spent in the tadpole stage.

According to Bailey (1944, Iowa Conservationist, 3: 17–20, 25, 27–30), Pope (1947, Amph. Rept. Chicago Area: 116) and Wright and Wright (1948, Handbook of frogs: 446) bullfrogs spend two winters in the tadpole stage. Walker (1946, Ohio State Mus. Sci. Bull., 1: 71) reports that in parts of Ohio there is some reason to believe that the tadpole period may be as short as 14–16 months.

Two specimens have been deposited in the Division of Herpetology at the University of Michigan Museum of Zoology.—W. D. KLIMSTRA, *Dept. Zoology and Entomology, Iowa State College, Ames, Iowa.*

THE HIBERNATION SITE OF THREE SNAKES AND A SALAMANDER.—During February, 1949, several hibernating reptiles and one salamander were found, incidental to the excavation of a woodchuck den, though not in the burrow. The den site was located on a terrace between a river flood plain and a cropped field. On February 8 a pink-bellied snake, *Carphophis a. amoena*, was found 24 inches below the surface. The snake was 101 mm. in length. Further excavation of the same area on February 15 unearthed a brown snake, *Haldea v. valeriae*, 212 mm. long, which was located 30 inches below the surface, and a 280 mm. ring-necked snake, *Diadophis punctatus edwardsii*, which was found at a depth of 32 inches.

A red-backed salamander, *Plethodon c. cinereus*, also found on February 15, was located 35 inches below the surface.

All of the snakes and the salamander were active immediately after discovery. The tongues of the snakes were extended several times and normal wriggling movements were noted. None of the animals were curled up and no nest chambers were found. No well-used reptile or amphibian burrows were noticed and each animal was found some distance from the woodchuck runways. Apparently the snakes and the salamander

had burrowed into the soil and, after reaching the desired depth or location, remained in a dormant condition. It was interesting to note the contrast between the deep sleep of the hibernating woodchuck and the immediate activity of the snakes and salamander.

The dominant vegetation in the vicinity of the excavation site is Virginia pine, *Pinus virginiana*. All animals found were in the B horizon (subsoil). The soil type is Elsinboro gravelly sandy loam. The soil temperature during the excavation period was 9.5° C.

William C. Good assisted with the excavation work and William H. Stickel identified the specimens.—Roy A. Grizzell, Jr., *Fish and Wildlife Service, Patuxent Research Refuge, Laurel, Maryland.*

A WHITE SPADE-FOOT TOAD FROM THE NEW MEXICO WHITE SANDS.—Several species of animals showing white coloration adaptation have been collected from the White Sands National Monument, New Mexico. Dice (1929, Occ. Pap. Mus. Zool., Univ. Mich., 203: 1–4) described the light colored race of the pocket mouse *Perognathus apache gypsi*. Strohecker (1947, Ann. Ent. Soc. Amer., 40: 241–246) described two new camel-crickets of the family Gryllacrididae, both of which are white in color. H. M. Smith (1939, Publ. Field Mus. Nat. Hist., Zool. Series, 24: 339–344) described a white race of lizard, *Holbrookia maculata ruthveni*.

On the night of July 4, 1946, I collected a white spadefoot toad from the central part of the White Sands National Monument, but the specimen escaped before I was able to have it identified. During the course of a survey of the arthropod fauna of the White Sands in the summer of 1947, I collected a number of additional specimens of toads. The first specimen collected in 1947 was sent to our laboratory where it was kept alive for several weeks and eventually identified as *Scaphiopus couchii* Baird by H. M. Smith, of the University of Illinois. When collected near the base of a gypsum dune on white substrate at night, the specimen was completely white except for black eyes and black marks on the under-side of the hind feet. In the laboratory, however, it gradually darkened, approaching the color typical of the species. All other specimens taken in the dunes area were white when captured. Specimens taken from areas outside the dunes were light in color but not nearly so light as those from the dunes area.

Observations indicate that these toads bury themselves in the sand-like gypsum at the bases of dunes. They were found on the surface only at night. Large numbers were observed abroad the night of the first rain of the season. They seemed to be traveling in a southeasterly direction, possibly toward areas where water stands in the surrounding desert following rainfall.—Clyde P. Stroud, *New Mexico Highlands University, Las Vegas, New Mexico.*

OPHIOPHAGY BY A JUVENILE COPPERHEAD.—A juvenile *Agkistrodon c. mokeson*, born at this zoo on September 20, 1947, refused the invertebrate food offered. On November 23 it was seen swallowing a small *Natrix r. rhombifera*. The water snake, however, was too large, and 5 or 6 mm. of its tail remained projecting from the mouth of the copperhead until the latter died on November 29. The copperhead measured 235 mm. and the water snake 178 mm.

In view of the indiscriminate appetite of copperheads, ophiophagy is not surprising, but the attempt at such a large meal and the subsequent failure to regurgitate it before the fatal termination seem unusual.—A. J. Barton, *Highland Park Zoological Gardens, Pittsburgh 6, Pennsylvania.*

MEDAESTIA WUSSOW, 1916, A SYNONYM OF *TESTUDO* LINNAEUS, 1758.—W. Wussow established in his essay "Meine Erfahrungen mit *Testudo horsfieldi*" (1916, Wochenschrift Aquarien-Terrarien Kunde, 13: 170) the name of *Medaestia* as a subgenus of *Testudo* Linnaeus. He failed to give a diagnosis, but he enumerates the species as follows: *Medaestia graeca, ibera, leithi;* he further mentions *Medaestia horsfieldi*. The determination of the genotype not having been given, I fix it herewith as *graeca (hermanni* Gmelin). Thus *Medaestia,* a name hitherto overlooked in nomenclatorial works, becomes a synonym of *Testudo* Linnaeus.—Robert Mertens, *Senckenbergisches Museum, Frankfort a/M., Germany.*

THE SMOOTH GREEN SNAKE IN TEXAS.—In the latest review of the smooth green snakes, *Opheodrys vernalis* (Harlan), Grobman (1941, Misc. Publ. Mus. Zool., Univ. Mich., 50) discarded all Texas records of the species, along with those from several other southern states, with the comment that they "are obviously in error." His main points of argument are that the specimens were either outside *his* accepted range or that the collector's data are unreliable.

The status of *Opheodrys vernalis* in Texas is again brought to attention by the capture of a male specimen 2½ miles west of Sealy, Austin County, on April 23, 1949. A group of us stopped to collect herpetological specimens at a temporary rain pool in the open prairie and among other species found 1 specimen of *O. vernalis*. It was in short grass in the highway right-of-way, so that doubting Thomases might invoke the theory of "escaped pet." If so, then the same argument should apply to our capture of a specimen of *Rana areolata* at the same locality, since there is a hiatus between the main range of this frog and the Texas localities (Austin, Calhoun, Colorado, Galveston, and Harris counties). Because of this recent capture of *vernalis*, I am inclined to accept the records from Bosque, Ellis and Matagorda counties, Texas, as authentic.

Our specimen of *ventralis* has 137 ventrals, hence appears referable to *Opheodrys vernalis blanchardi* Grobman.—WILLIAM B. DAVIS, *Department of Wildlife Management, Texas A. and M. College, College Station, Texas.*

FURTHER NORTHERN RECORDS OF THE WOOD-FROG.—Northern records of the wood-frog based on material in the National Museum of Canada collection were listed with measurements in COPEIA (1939, p. 235). The Museum recently received two adult *Rana sylvatica cantabrigensis* from the Mackenzie Delta, 67°48'N., 134°44'W., collected by W. E. Stevens, three adults and three juveniles taken at Beech Bay, Churchill, Manitoba, by B. Hocking, and a juvenile collected by Bruce S. Wright, 35 miles up the Koksoak River which flows into Ungava Bay bounding northern Quebec.

The following table gives the measurements in mm. of the body length, length of leg to heel, and length of foot of the specimens:

LOCALITY	BODY	LEG	FOOT
Mackenzie Delta, N.W.T.	48	41	36
June 28, 1948	39	30	27
Average	43.5	35.5	31.5
Churchill, Manitoba (adult)	42	29	27
June 22, 1947	40	28	26
	35	28	24
Average	39	28.3	25.6
Churchill, Manitoba (juvenile)	19	14	11
June 22, 1947	19	12	10
	18	11	9
Average	18.6	12.3	10
Koksoak River, Quebec (juvenile) August 30, 1948	20	14	12

The three localities listed extend the previously known range considerably northward, and the fact that in the Churchill specimens the leg and foot measurements average proportionately shorter than in any other individuals in our collection, including four adults from Herchmer, Manitoba, only 100 miles south of Churchill, seems note worthy.

The Mackenzie Delta frogs are probably the first Canadian herpetological specimens to be recorded 100 miles north of the Arctic Circle, and the discovery of the Koksoak River juvenile indicates the probability of the wood-frog occurring in suitable habitats throughout the province of Quebec.—CLYDE L. PATCH, *National Museum of Canada, Ottawa, Ontario.*

NOTES ON THE DESERT WHIPTAIL LIZARD IN UTAH.—The desert whiptail lizard, *Cnemidophorus tigris tigris* Baird and Girard (*tesselatus tesselatus*), is common in the Dinosaur National Monument, in extreme northwestern Colorado and northeastern Utah. It is commonly found in brushy canyon bottoms where it utilizes the protection of the shrubs, as described by Charles E. Burt in his monograph of the genus (1931, Bull. 154, U. S. Nat. Mus., 1–286). It is known from Monument Headquarters, in Uinta County, Utah, and from most of the canyon parks and benches in the Monument. The lizards are typically shy but in the Headquarters area they have become accustomed to the presence of human beings and may be observed freely as they crawl through fallen leaves rooting for beetles and other insects, and occasionally catching and eating a smaller *Sceloporus*.

In referring to the copulation behavior of this lizard, Burt (*op. cit.*: 196) quotes Taylor to the effect that the species mates in June in Nevada, and Van Denburgh that it mates in California in early June. In line with these dates the following described copulation took place on May 31, 1948, at Dinosaur National Monument Headquarters, just in front of the museum at 2:00 P.M. on a warm, sunny day.

Both specimens were about the same size, 10 or 11 inches in length. The male pursued the female and after catching her with a biting grip on the back of the neck, grasped her with the forelegs. The female was thrown off balance, broke away, and was again caught after a short run of about 2 feet. The male held the female by the neck and mounted her back with his tail aligned with hers. He began a rhythmic precopulatory clinching of all four legs about her body. After approximately three minutes the male shifted his body so that it lay across hers at an angle of almost 90°, his head to her right, but their tails still parallel. The male then curled his body around hers so that his head was against her abdomen just forward of her right rear leg. His tail passed under hers back of the left rear leg and extended beyond her body to the right, placing the copulative organs in juxtaposition. This movement occupied about a minute and a half.

Upon completion of copulation both moved away together. One was walking with difficulty, dragging its hemipenes, which were retracted after traveling 5 or 6 feet. Ten minutes later they were observed still following one after the other about a foot to 18 inches apart, suggesting that mating may involve more than one copulation.—JESS LOMBARD, *Dinosaur National Monument, Jensen, Utah.*

NEST AND EGGS OF THE SOUTHERN DUSKY SALAMANDER, *DESMOGNATHUS FUSCUS AURICULATUS.*—Nests and eggs of the northern dusky salamander, *Desmognathus f. fuscus,* have been several times described, but nothing seems to have been recorded concerning the breeding habits of the southern subspecies, *D. f. auriculatus.* On June 16, 1948, a nesting female of this form was discovered on the Coastal Plain side of Augusta, Richmond County, Georgia. The nest was a shallow depression beneath a scrap of bark at the edge of a sandy spring run. The female, a small specimen of 40 mm. snout-vent length, was coiled about the eggs. The eggs, six in number, averaged 7.7 mm. in diameter. Four of the eggs were held together by thread-like extensions of the outer envelope; the other two were separate. All the eggs contained large, well developed embryos, whose spasmodic movements could be observed from time to time. The nest was transferred to a container, and in the process of transference the eggs were rolled about a bit. The female made no attempt to reassemble them later. Both recently hatched larvae and females with ovarian eggs had been collected near Augusta a few days previously; evidently the breeding season is an extended one in this region.

Augusta lies on the southern edge of the area of intergradation of *Desmognathus f. fuscus* and *D. f. auriculatus.* Specimens from the southeastern or Coastal Plain side of Augusta are usually small and dark, with a russet stripe on the dorsal surface of the tail, two rows of white spots along the sides, an orange-red mark between the eye and the angle of the jaw, and a grayish, mottled venter. Thus they seem referable to *auriculatus,* rather than to the typical subspecies.—WILFRED T. NEILL and FRANCIS L. ROSE, *Augusta, Georgia.*

EDITORIAL NOTES AND NEWS

Western Division Meeting

THE 18th annual meeting of the WESTERN DIVISION of the American Society of Ichthyologists and Herpetologists was held on June 15–18 at Vancouver, B. C., as part of the annual meeting of the Pacific Division of the AAAS.

Symposia were held on "New Methods of High Speed Oceanographic Research," with the American Society of Limnology and Oceanography, and on "Factors Influencing the Success of Reproduction in Anadromous and Shore Spawning Fishes," with the oceanographers and the Western Society of Naturalists. There were a half day of ichthyological papers and, in a joint meeting with the Herpetologists League, a half day of herpetological papers.

Two student second prizes were awarded for papers in ichthyology: to FREDERICK H. C. TAYLOR, Scripps Institution of Oceanography, La Jolla, California, and to ROLAND W. RADCLIFFE, University of British Columbia, Vancouver, B. C. There were no speakers eligible for herpetology awards.

The following officers were elected: *President,* JOHN L. HART, Pacific Biological Station, Nanaimo, B. C.; *Vice-President,* ROSS HARDY, Dept. of Zoology, Weber College, Ogden, Utah; *Secretary-Treasurer,* ANITA E. DAUGHERTY, California State Fisheries Laboratory, Terminal Island, Calif.—ANITA DAUGHERTY, *Secretary.*

Fish News at University of Michigan

DR. WILLIAM C. BECKMAN resigned from the Michigan Institute for Fisheries Research in July to become Leader of the newly created Colorado Cooperative Fisheries Research Unit and Associate Professor of Zoology at Colorado A and M College, Fort Collins.

DR. FRANK W. JOBES resigned from the U. S. Fish and Wildlife Service, Great Lakes Office, effective August 5, to become Professor and Head of the Biology Department, Yankton College, Yankton, South Dakota.

HENRY E. PREDMORE, JR., 28, aquatic biologist of the Michigan Institute for Fisheries Research, died at Ann Arbor on July 18, after a brief illness.

ROBERT C. GIBBS resigned as fishery biologist of the fish management program sponsored by the Associated Fishing Tackle Manufacturers to accept the position of fishery biologist, Department of Game, Fish and Parks, Woonsocket, South Dakota, effective in July.

EDWIN L. COOPER recently completed his doctoral research on age and growth of the brook trout and has accepted a position with the Fisheries Institute in charge of the newly created Pigeon River Trout Research Station.

Doctoral candidates in Fisheries working under PROF. KARL F. LAGLER, Department of Zoology, include: CARL D. RIGGS (life history and management of the white bass), who is now Acting Director of the Oklahoma Biological Survey; R. WELDON LARIMORE (life history and ecology of the warmouth bass); HERMAN KLEEREKOPER (the biology and management of a South American atherinid fish), who is a lecturer at McMaster University, Ontario; CHARLES K. FISHER (studies of ecology of mountain trout), of the California Division of Fish and Game; all of these men are working *in absentia.* MAX A. PROFFITT (body-scale relationship in the bluegill); VIRGIL S. PRATT (management and ecology of marginal trout streams in southern Michigan); ARTHUR K. ADAMS (beaver-trout relationships); WAYNE TODY (life history of the brown trout); VERNON C. APPLEGATE (life history and control of the sea lamprey in the Great Lakes), co-operating with DR. ALFRED PERLMUTTER of the U. S. Fish and Wildlife Service. MESSRS. PRATT, ADAMS, TODY, and APPLEGATE are on fellowships with the Michigan Institute for Fisheries Research.

Doctoral candidates working under PROF. REEVE M. BAILEY in the Museum of Zoology, include: VIANNEY LEGENDRE (revision of the pikes), of the University of Montreal, Quebec; WILLIAM RALPH TAYLOR (systematic revision of *Schilbeodes*), Assistant in the Division of Fishes.

PROF. LAGLER is currently continuing field studies and research on the fishes of Michigan and the Great Lakes region.

PROF. ROBERT R. MILLER has recently received a research grant, from the Rackham School of Graduate Studies, for studying the ecology, systematics and evolution of the fishes of the lower Colorado River. He plans to spend 4 months in the field, in Arizona, New Mexico and Mexico, early in 1950. This is a continuation of current research work on freshwater fishes of western North America. A treatise on the freshwater fishes of Guatemala is also in preparation.

News Notes

RODGERS D. HAMILTON, of the University of Michigan, has received another Arctic Institute of North America grant, to continue his studies of the zoogeography and ecology of *Rana sylvatica* in the Arctic. He has also joined the staff of the Arctic Research Laboratory of the Office of Navel Research, at Point Barrow, Alaska, on a contract with Johns Hopkins University. His address is Arctic Research Laboratory, Box 1310, Fairbanks, Alaska. Correspondence should be sent air-mail. Material other than first-class mail should be sent to 554 East End Ave., Pittsburgh 21, Pennsylvania.

DR. DONALD E. WOHLSCHLAG, midwestern expert on freshwater fish and plant life, joined the staff of Stanford University on September 1, as assistant professor of biological sciences.

DR. EDWARD C. RANEY, of Cornell University, has been engaged by the Saltwater Sportsman and the Massachusetts Fish and Game Association to undertake a study of the literature, research under way, and make recommendations for coastwise program on the striped bass. This study is coordinated with those of other interested groups including the Atlantic States Marine Fishery Commission and the Fish and Wildlife Service.

Word has been received of the death, on March 31, 1949, of DR. VLADIMIR V. TCHERNAVIN, ichthyologist at the British Museum. Dr. Tchernavin is best known for his work on the life history of the salmon, particularly the morphological changes correlated with breeding condition. He was 62 years old.

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